MAY 27 1932

MAINTENANCE ENGINEERING

In Plants, Mills, and Factories

EVERY maintenance engineer rightfully may be expected to know investment and operating costs before he decides on the type of drive he will install.

For a given set of conditions there is one best drive. Only when he knows all the facts is the engineer justified in issuing specifications and orders.

Beginning in this issue: A five-article series, "Individual and Group Drives—Investment and Operating Cost Data," by Robert Drake.

25 cents a copy—McGraw-Hill Publishing Company, Inc.

JUNE
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MAINTENANCE ENGINEERING

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JUNE
1932

INDIVIDUAL AND GROUP DRIVES

Investment and Operating Cost Data

ROBERT DRAKE

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IT IS very uncommon to find a plant in which careful study of the economic, manufacturing, and production considerations points to the exclusive use of either group drive or individual drive. After eliminating those departments or portions of departments in which one or the other type of drive offers definite and marked advantages from a manufacturing standpoint, there remains a considerable portion of the plant where one method will give just about as good results as the other, if both are planned with equal intelligence. It is in the choice of drives for these portions of the plant that the economic considerations should be weighed most carefully. To this great middle ground the following conclusions apply:

1. In the typical American manufacturing plant, which averages over a ten-year period a little less than single-shift operation at maximum capacity, with a large night shift in the busy season of boom years and short-time operation in the depths of a depression, the first cost of electrical power and mechanical transmission items, including power factor correction equipment, switchboards, distribution cables, and ducts, for the individually driven plant is 80 to 95 per cent more than for corresponding group-driven plants.

The total annual costs, including fixed charges, for the same equipment listed above are about a third higher for individual than for group drive — a trifle more if the individual-drive motors average only 1- or 2-hp. rating.

2. For the familiar "feast or famine" industry — the plant in which some departments work day and night while other departments have nothing to do, and which shuts down almost entirely in a depression year or in the dull season — the total annual cost will amount to about 50 per cent more for individual than for group drive. The cost will be somewhat higher, relatively, if the individual motors average only 1 or 2 hp. in size.

The first cost of the whole power layout, including the mechanical power transmission and other items mentioned under the preceding example, will be from 2 to 2.2 times as great for individual as for group drive. The lower figure will hold for an industry in which 4- to 10-hp. motors on the average are required on individual drives. The larger figure will apply when the motors are smaller, say, 1 to 2 hp.

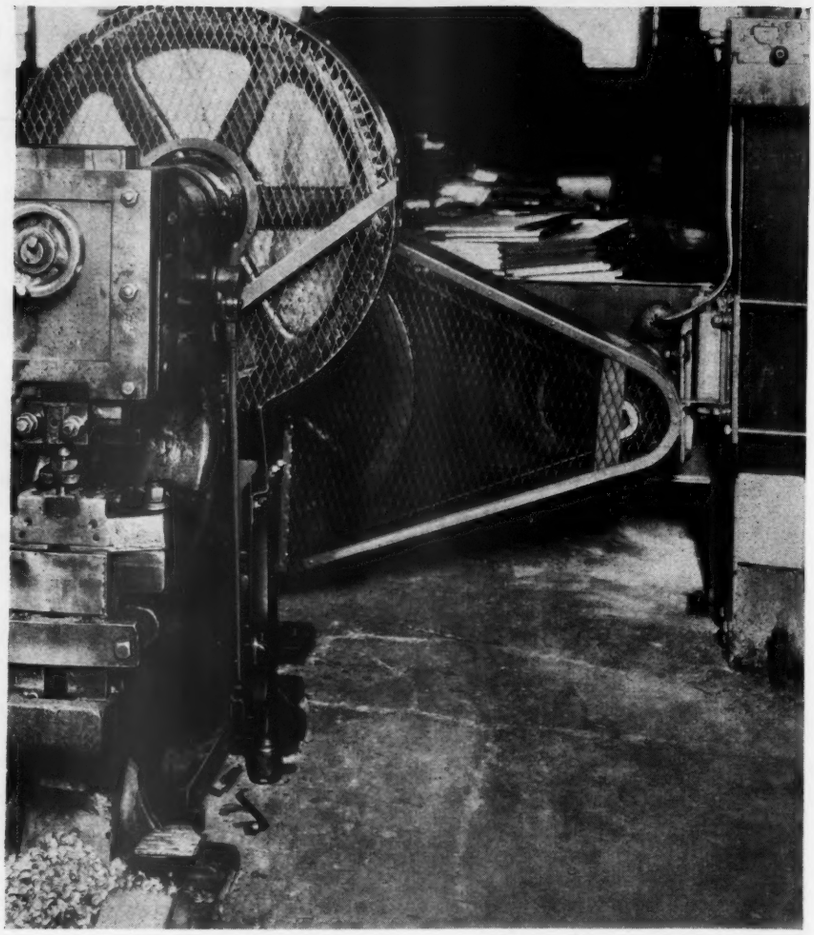
3. In a plant that averages two shifts, except for single-shift operation in a dull season of three or four months' duration, with three shifts in boom years and one shift in depression years, the total annual costs for individual drive will be 25 per cent greater than for group drive. These costs will be a trifle more if the individual-drive motors average 1- to 2-hp. rating, and a trifle less if they average 5 to 10 hp.

The initial investment in electrical power and mechanical transmission equipment, including power factor correction equipment, switchboards, distribution cables, and all, will be about 80 per cent greater for individual drive than for group drive. The investment will be on the order of 10 per cent less if the motors are 5- to 10-hp. rating, and 10 per cent more if the average size is 1 and 2 hp. Such plants are very uncommon.

The assumptions as to performance on which these comparisons are based apply to the best-planned and operated plants of their respective types, not to average plants.

Details of the studies that have led to these and other conclusions bearing on the use of group and individual drives will be given in a series of five articles, of which the first begins on the next page. The remaining articles of the series will appear in succeeding issues.

Improvements of last 10 years in motor drive apparatus and mechanical transmission equipment. Effect on comparison of first costs and annual costs. Consideration of relative advantages and disadvantages from a manufacturing and production standpoint.



Individual-drive motors are often subjected to iron chips and other harmful materials, when mounted close to the floor. To protect it, the motor driving this press has been mounted on a pivoted base attached to a pillar. The center distance is 40 in. and the motor and driven pulleys are 4½ and 36 in. in diameter, respectively.

SEVERAL years ago (February, March, and April, 1924), I presented in this publication, then known as *Industrial Engineer,* a study of group and individual drives, pointing out the respective fields of greatest usefulness. There was a discussion of the comparative advantages and disadvantages of the two types of drive for the many applications in which both are suitable. Included was a brief comparison applying to one set of manufacturing conditions only. The subject will be reviewed in this series of articles, with a broader consideration of comparative first costs and operating costs, and a discussion of some developments that have taken place in the intervening years.

The past ten years have witnessed the development of a number of important improvements in motors and mechanical transmission equipment. In the metal-working and several other industries, frequency of breakdowns and repair expense have been very high for individual-drive motors. For this fact there are four principal causes:

1. Individual motors are frequently mounted so low that metal chips, grinder sludge, or metal dust may enter them.

2. Roasting out caused by extraordinary power demands from the driven machine, due to an unusually heavy job or stiffness of a machine after overhauling. This trouble is less common in group motors; unusual demands on a motor made by one or two machines in a group are seldom enough to overheat it seriously.

3. Individual-drive motors are ordinarily small, as compared with group-drive motors. The partially closed slot windings used in these motors are less rugged than the complete, form-wound coils used in the larger sizes ordinarily applied to group drives.

4. Some trustworthy employee can be delegated to start a group-drive motor and properly instructed, but in an individual-drive shop everyone starts motors, the uninstructed and the recently hired as often as anyone else.

The first of these difficulties was the most serious. Enclosed, ventilated motors were not a solution. When enclosures with coarse openings were used, metal particles entered the air gap and injured the coils. When very fine enclosures were used a mixture of oil and dust or larger particles stopped them up and the motor roasted out. This difficulty has been effectively met, in the sizes most often used for individual drive, by totally enclosed, fan-cooled motors. Designs are available in which the early difficulties with light, spun-copper enclosures, close running clearances, and so on, are absent. Thus, at one step the motor failures on individual drives have been reduced by more than half.

Enclosed motors and enclosed, fan-cooled motors are rated on a different temperature basis than are open motors (55 deg. C. rise instead of 40 deg. C. rise). This is equivalent to a 20 per cent difference in actual continuous capacity for the same nominal rating. Open motors may be overloaded 20 per cent continuously without heating any more than will enclosed, fan-cooled motors operated at nameplate rating. Hence, for the same application, enclosed fan-cooled motors cost about twice as

much as open motors. Despite this fact, their use is advisable on the majority of individual drives in the metal-working and many other industries.

The fourth difficulty listed above has been largely eliminated by the development of the full-voltage-starting motor and the automatic compensator. At some sacrifice in performance characteristics, principally in power factor at heavy loads and in stalling torque, a compensator is not necessary with motors up to about 30-hp. rating. The motor cost is not increased materially. The starter cost is reduced, but the saving is largely offset by the cost of the power factor correcting equipment necessary, the additional copper required in the distribution system, and the increased losses in both. There is a gain in reliability, for starter troubles are greatly reduced. Motor burnouts caused by holding the compensator on the "starting side" when the motor fails to start are definitely eliminated.

Increased use of automatic compensators has largely eliminated motor failures caused by ignorance in handling the manual type, and has reduced starter maintenance costs. Ten years ago such equipment of the best design cost as much as the motor it controlled, in the sizes most needed. Now the additional cost of automatic starters in the 30-hp. to 50-hp. sizes is roughly 20 per cent of the motor cost. This increase is warranted on individual drives whenever manufacturing delays are likely to prove costly.

When care is exercised in selecting and instructing the men delegated to start group-drive motors, automatic compensators will not ordinarily save their added cost in reduced maintenance. However, if the cost of manufacturing delays is considered, their use is ordinarily advisable.

Various methods have been introduced to provide a reliable speed reduction of large ratio on individually driven machine tool motors, without using a pinion on the motor shaft. Slow-speed motors, formerly necessary to obtain reliability and acceptable bearing life with pinion drives, are no longer essential. The increasing use of compressed cloth, rawhide, and bakelite-impregnated canvas for motor pinions has decidedly reduced the punishment on motor bearings.

These developments, particularly the former, decidedly reduce the number of odd motors and spares required in certain kinds of shops. The cost of the spare motor is saved, but ordinarily the cost of such speed-reducing devices is high, if they are durably constructed. There is a definite gain in the electrical characteristics, because the fractional-load performance of slow-speed motors is poor.

There have been a number of outstanding advances that have benefitted group and individual drives alike. Among such aids to the reliability of all types of drives may be mentioned routine dipping and baking of stators, wound rotors, and direct-current armatures; ball and roller motor bearings; and improved short-center belt drives.

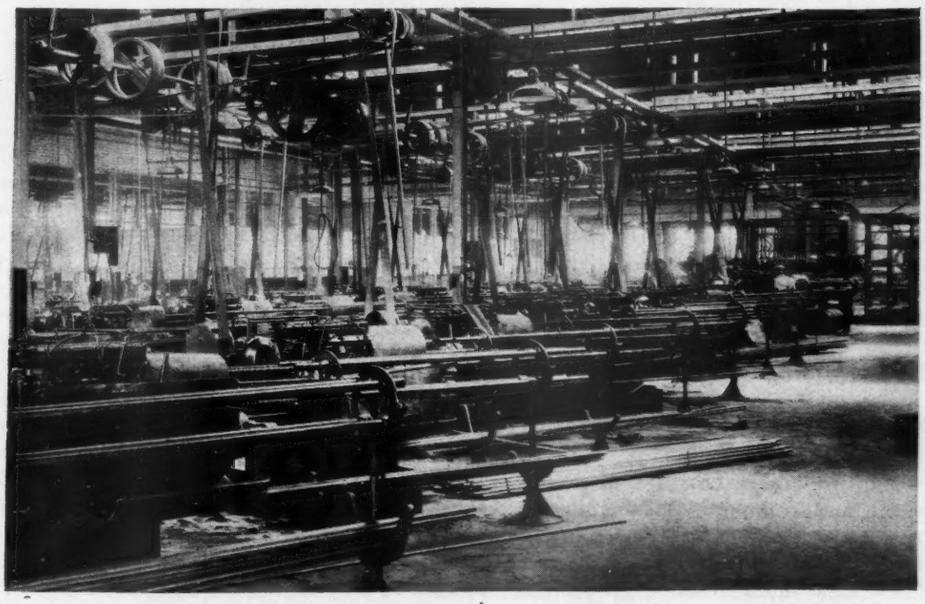
Motor winding failures due to bearing troubles have been reduced by the use of ball and roller bearings. These bearings ordinarily become noisy before sufficient wear occurs to allow the rotor to rub on the stator.

Oiling labor is almost eliminated, because such bearings require greasing only once in six months to once in two years, depending upon the design of the bearing enclosure. However, the periods between motor inspections cannot be correspondingly increased without an increase in motor failures chiefly from roast-outs. My recommendation is inspection two or three times a week for motors with antifriction bearings and daily inspections for sleeve-bearing motors where manufacturing delays are costly, although the resulting decrease in repair expense will not warrant such frequent inspections.

Antifriction bearings when properly applied have long life. From the operating man's standpoint their principal drawback is that they will not stand the thrust that results from driving on pulleys, pinions, or sprockets, even when carefully "dollied up." The additional delay when changing motors in a hurry is disheartening. When such abuse is necessary to maintain production the bearings should be replaced at the very first opportunity. When antifriction bearings are first applied in a shop where the maintenance force is accustomed to sleeve bearings, this lesson must be thoroughly learned before the expected decrease in motor failures will be realized.

The widespread tendency to dip and bake stators of rewound motors, and as a routine maintenance practice, has definitely reduced motor winding failures, when a high-grade, oil-proof, heat-resistant transformer varnish is used. The results have been very marked in plants where failures to ground were formerly common, due to cast-iron dust working into partially closed slot windings. This method of sealing windings against the entrance of foreign matter originated in street railway shops, but it has been used in many industrial plants for five to ten years.

Ten years ago many engineers



Screw machines are one type of equipment that lends itself well to group drive.

preferred, in principle, a belt for driving from motor to load because it absorbed shocks, produced no vibration, and often saved the machine by slipping or coming off when something jammed. In practice occasional difficulty was experienced with such drives when the speed ratio was considerable and the centers short, as was generally the case with individually driven machines and frequently with group drives. To be sure, the gravity idler was available. This drive was never so widely used, however, as its excellent performance warranted. The engineering data necessary for its successful application were not widely distributed and the drive was never marketed in such a manner that the user could select a suitable unit drive complete from a catalog and order it without further correspondence.

During the past few years this situation has largely disappeared. There are available on the market a number of types of belt drives that give excellent service on short centers, exhibiting low slip and acceptable life. Worthy of mention are the pivoted-motor-base, flat-leather-belt drive, and the rubber V-belt drive.

Where extreme speed ratios are required improvements in the design of the so-called automotive-type worm gear speed reducer have greatly increased the life and efficiency of such equipment. More general recognition of the ratio limits of the several types of worm gear and spur gear speed reducers and the very general use of antifriction bearings have greatly decreased the losses. The application of such equipment is becoming an intelligent selection of the best type for the purpose in view, based largely on speed ratio. Furthermore, the leading manufacturers realize that with motor drives they must apply their reducers with regard to the actual short-time overloads that a motor can and does carry, and not on the basis of its continuous rating.

A speed reducer, belt drive, or whatever connects the motor to the driven equipment must have long life when carrying 50 per cent overload for an hour occasionally and 100 per cent overload momentarily, particularly at starting.

Ball and roller bearings in groupshaft and countershaft hangers are now more usual in new installations than was the case ten years ago. The consequent elimination of groupshaft speed limitations has initiated a tendency to higher shaft speeds which is evident as yet only in a few of the newer installations.

Throughout the ten-year period in question the matter of standardization of mounting dimensions, shaft location, and shaft size for all makes of motors of the same horsepower and speed has been agitated. First initiated by the Association of Iron and Steel Electrical Engineers this great advance has progressed until the more commonly used types of a.c. motors may be obtained in general standard dimensions (the N.E.M.A. standard). The effect on investment costs in all future installations will be important.

When a new plant installs these motors it will be necessary to carry only one general line of spares for many years to come. The number of "orphan" motors and the necessary spares will be minimized. In the past, even though a purchaser bought all of his motors from one manufacturer, he was obliged to purchase a complete additional line of spares every four or five years. Many an old plant that has been motor driven for twenty five to thirty years is obliged to stock from four to six fairly complete lines of spare motors.

All in all, the past ten years have seen a decided advance in the reliability and efficiency of motors, accessories, and mechanical transmission details.

Plant men who are considering a new installation oftentimes want to know which is "best"—group or individual drive. This is like determining the relative superiority of man and woman. There is no answer possible to the general question.

Individual and group drive each has its own province where its superiority is seldom questioned. There is, however, a great middle ground where there is very little difference in suitability. The choice, unless made on a basis of personal preference, must be based on a most careful consideration of: (1) Comparative first costs. (2) Total annual operating expenses. (3) Such minor advantages and disadvantages from the production standpoint as can be foreseen from experience with similar installations. Unfortunately, a decision is often influenced by prejudice based upon unfortunate experience with installations that are obsolete, unintelligently planned, or made under conditions where the alternative method would be superior.

Scarcely ever may it be said of a large industrial plant, "This plant should be group driven," or "This plant should be individually driven," as the case may be. For the best results both types of drives should be used, each in its proper place.

Without question individual drive should be used in areas requiring overhead crane service; on machines that would require countershafts if grouped and which are likely to be moved frequently as activity in departments varies; on machines that require considerable power—say 20 to 30 hp. or more—operating at a fairly constant load well above half load; on a few machines scattered over a large area; and in instances where the requirements of production or materials handling are best met by locating machines at odd angles.

Similarly, group drive is most suitable where the power consumption of machines is extremely variable, with occasional very high peaks of some seconds' duration.

Under most industrial conditions group-drive motors are best mounted overhead, usually on the ceiling. This factor ordinarily limits the motor size to 100 hp. or less, preferably not over 50 hp. Larger motors are rather unwieldy to replace quickly in case of failure.

Under usual conditions group-drive motors larger than 50 hp. would not be used except for groups of machines requiring so much power that only three or four could be driven by a 50-hp. motor. With only three or four machines in a group one fundamental advantage of a group drive is sacrificed—the saving in total installed motor capacity based on the fact that the maximum power demands of the individual machines do not occur simultaneously.

With so few as four machines in a group it is not safe to assume that half or more of them will not occasionally work into step. Then if the individual loads are very fluctuating stalling trouble may occasionally be experienced. It is in order in such cases to use a 75-hp. or 100-hp. motor and increase the number of machines in a group to eight, ten, or twelve. If the power consumption of the individual machines is not too variable it may be well to consider the possibility of driving them individually.

With very intermittent loads and occasional extremely sharp peaks that would stall any size of individual motor reasonably proportioned to the average load, it has in some cases

been found advisable to build up large groups. An example is rubber mills, which are sometimes driven in groups requiring several hundred horsepower each.

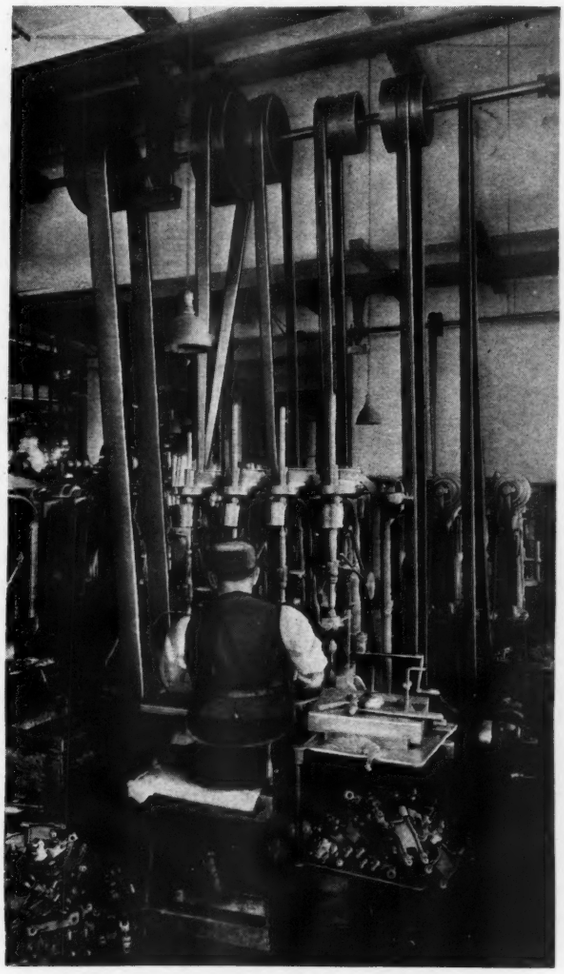
In deciding which type of drive offers the greater advantages, departments, not entire plants, must be considered as units. A large industrial plant is really an aggregation of small factories inside one fence. We cannot lump a foundry and an assembly department, a sheet-metal department and a wood shop, a forge shop and a machine shop, in making a decision. Frequently for best results units smaller than a department must be considered, grouping here, individually driving there, and occasionally individually driving a single machine located within an area covered by a group.

Ordinarily the choice between individual and group drive must depend upon comparative first costs and annual operating expenses, and upon the effect of the type of drive on manufacturing conditions.

It is not impossible to arrive at useful general conclusions with regard to first costs and annual costs for individual and group drives. The factors controlling the comparative costs may be determined, industry classified according to the most important factors, and costs established that are based upon actual figures from plants in operation, for a number of classes of industry. Such a cost analysis will be attempted and certain conclusions drawn therefrom in later articles in this series.

It is impossible, or useless, to generalize on the advantages and disadvantages from a manufacturing or production standpoint of the two types of drives under consideration. The characteristics that favor one method of driving under one set of conditions may be the principal argument against it in another industry. For example, consider breakdowns with the resulting delays to production.

When a group-drive motor fails completely an hour or more ordinarily is required to substitute a spare, or install a motor on the floor and lace a temporary belt. Such a delay involves a number of machines, disorganizes production, and frequently interferes with painting, assembly, or shipping on the following day. Such occurrences are, however, comparatively rare.



A good arrangement of group drive with a small number of machines, permitting accurate selection of motor size to meet power requirements.

In a plant where corrosive fumes are absent and maintenance and inspection are well organized, there need not be more than one such delay (one hour or more) a year for each 100 group-drive motors installed. Under favorable conditions some plants have operated for years with less than half that number of delays.

On the other hand, with individual drive the motors are smaller and therefore less rugged. They lack the protection against extreme load fluctuations afforded by the diversity inherent in a group of several machines. The number of motor failures per 100 motors in operation will be decidedly greater than in the case of group drive. Furthermore, to drive the same number of machines there will be from 10 to 30 times as many motors installed.

What is the effect of these facts upon production? Consider a plant containing 100 groups of 20 machines each and experiencing in an average year one serious group-drive motor failure causing a delay of more than an hour. Ordinarily in a plant of this size no special equipment is available for quickly mounting a motor on the ceiling. It may be assumed that the men employed in the group affected will be sent home for the remainder of the shift. Thus, on the average, one-half shift would be lost each year for one group out of the hundred.

If the 2,000 machines in this plant were individually driven with enclosed, fan-cooled motors, a fair assumption would be one similar delay every five working days, but affecting one machine only. With individual drive and open motors in machine shop work involving cast iron, one delay a day would be close to the facts. The operator would not be sent home; a foreman can always find work for one man.

It should be considered here that although almost every group-driven plant of this size carries spare motors, many individually driven plants have accumulated such a variety of motors in the course of years that it is impracticable to carry a complete line of spares. In such plants delays not uncommonly continue until an "orphan" motor can be rewound and returned to service.

Which situation is preferable from the production standpoint? It all depends upon circumstances, chiefly the type of industry and the production methods employed.

Consider a plant producing a great diversity of product in lots of small and moderate size. In designing similar devices identical piece parts are used wherever possible in order to reduce the variety of pieces stocked. The devices required on an

order are assembled largely, if not entirely, from finished pieces in stock.

In such a shop an individually driven machine may be out of service for an hour, or even a day, without seriously interfering with production. In the extreme case where there is no spare motor in stock a delay of several days while the motor is being rewound ordinarily is not serious. If there are duplicate machines one or more may be operated overtime to make up the lost production. In such a shop the failure of individual-drive motors only occasionally causes serious difficulty.

With group drive a failure requiring substitution of a spare motor is in many cases more troublesome and more serious from a production standpoint. Many machines are out of service. It is not possible in a single department to shift so many idle men to useful work. If no identical spare motor is in stock it may be necessary to substitute a larger motor, and the delay will ordinarily exceed two hours. In many plants the men would be sent home for the remainder of the shift. Under these conditions individual drive has the advantage, so far as interference with production schedules is concerned.

The fact must be kept in mind, however, that with groups of, say 20 machines, there will be about 60 times as many motor failures in a year with individual drive as there would be with group drives using enclosed, fan-cooled motors.

Now let us go to the other extreme —mass production carried to the limit that has been reached in the larger industrial units. A factory employing several thousand men may produce less than a dozen items, and only one or two at any one time.

Rough forgings and castings enter a department at the edges. The requisite operations are performed as the parts pass from machine to machine toward the assembly chain down the center of the room. In the case of most piece parts there is no storage of finished parts.

What happens in case of motor failure here? If group drive is used the assembly chain stops within a very few minutes. Painting, packing, and shipping continue for a while, an hour more or less, but a delay is inevitably experienced within a short time, whether or not assembly soon starts up again.

The duration of the delays depends entirely upon the time required to replace the defective motor or starter or apply first aid pending a more convenient time for replacement. With proper planning and organization a delay should not exceed one hour, more than once a year for each 100 group-drive motors.

In the case of individual-drive motor failures the results are equally disastrous. As a rule assembly must cease within a short time, less than an hour. Only in cases where a number of machines perform the same operation is there a chance to continue assembly at a reduced rate. Thus far it appears as though one type of drive were as bad as the other. Failure of any motor or machine tool is a threat at continuity of assembly, and on that depend all subsequent operations of finishing, packing, and so on. So far as power drive is concerned the difference is in the number of motors involved.

In a large, individually driven plant there may be such a minor production crisis several times each week with more or less delay in assembly and all subsequent operations. In a similar plant that is group driven the delays will occur only a few times per year, not a few times per week. True, there are frequent minor troubles with machine belts, but these are of little consequence from the production standpoint, because machine belts may be repaired or replaced in a very few minutes. There are enough finished pieces waiting before the assembly line to bridge such a delay.

Furthermore, there are similar troubles with the mechanical transmission on individually driven machines; these troubles may be less frequent but involve longer delays.

All in all, under such conditions group drive has much the better of it so far as continuity of production is concerned.

Another condition is represented by the small jobbing shop. There may be some duplication of machines, but in many instances there is only one machine of a kind. No spare motors are stocked. In such a shop a motor failure on one machine may hold up shipments for some days, but there is generally other work for the operator.

With group drive such failures occur very rarely, but they shut the shop down for a day or two.

These two examples, at the extreme limits of ordinary manufacturing practice, illustrate my original statement. It is impossible to generalize accurately on the comparative effect of group and individual drive upon continuity of production, convenience of production, and such matters. Each case must be considered separately in the light of the manufacturing conditions. Too often an engineer who has experienced the difficulties inherent in one type of drive fails to recognize that circumstances alter cases, and forms a lifelong prejudice. Similarly, we are all prone to picture in detail the evils of any system with which we are familiar, and overlook the fact that the possible alternative methods also have their disadvantages.

This situation applies as well to the convenience of moving a machine to a new location. If the machine has no countershaft, simply a pulley on the group shaft and a belt, the chances are that a group-driven machine will be easier to move than an individually driven one which must be wired up. If the conduit cannot be run overhead, but must be run through straddle blocks in a block floor, the cost will be still greater.

It is just as easy to think of a group-driven machine that requires a two-speed countershaft or something of the sort, and a temporary need for an individually driven machine which eliminates the necessity for a proper, permanent electrical job, thus reversing the advantage.

Succeeding articles in this series will discuss in some detail the factors that influence the comparative first costs and annual costs of group and individual drives, with examples from different types of industries, and the corresponding typical comparative performance.

Article II will be published in the July issue. It will consist of a discussion of the difference in first and operating costs for the two types of drives; a difference due to the fact that for group drives the excess of total connected motor load over maximum demand load usually is smaller than for individual drive.— July issue, second article.

Periodic Inactivity Complicates Motor Maintenance

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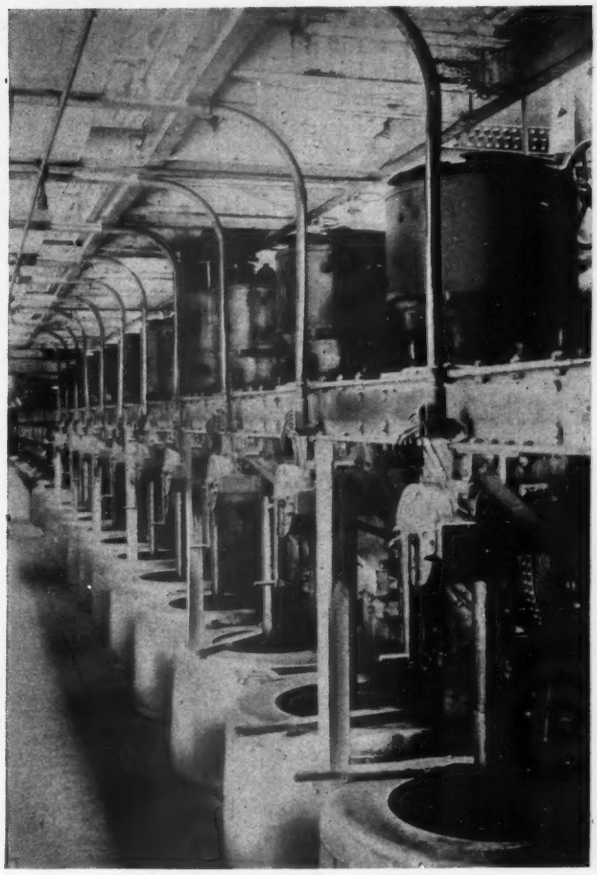


A row of two-speed, vertical motors, 600/1,200 r.p.m., driving centrifugal machines. Holes are drilled around stator frames for ventilation. Coils are wound with asbestos-covered magnet wire. Slot insulation is mica. The insulation resistance of these windings holds up very well throughout the idle season without drying.

IN INDUSTRIES where operation is seasonal, and where there are long periods of inactivity, maintenance of electric motors is a different problem from that in plants where the work continues for practically the entire year. Seasonal plants exist where the raw materials must be gathered or harvested at certain seasons of the year, and where it cannot be stored for any appreciable length of time. In such plants electrical equipment, especially motors, suffers more from deterioration during long periods of disuse than from wear and tear in operation.

Windings of motors under such conditions suffer most, principally from moisture and mildew. These conditions are dangerous in the case of motors of the higher voltages, especially with motors as high as 2,200 volts. However, the danger of insulation breakdown is sufficiently great even with 440-volt motors to be guarded against carefully.

Where electric motors are subjected to long periods of disuse, the problems of their maintenance present peculiar difficulties. This article describes motor maintenance in a sugar factory

Let us consider a certain raw sugar factory as a typical industry where the operating season may last from three to six months in the year. This plant has a total connected motor load of about 6,000 hp. The motors range from 1/20 hp. to 250 hp., and are single-phase and three-phase, squirrel-cage and wound-rotor, of such types as vertical, horizontal, back-geared, single- and double-speed, ball and sleeve bearings, open and totally inclosed. Many of them are located outside of the plant and some at the end of transmission lines from 1 to 8 miles long.

At the end of an operating season a complete washdown is given the plant with fire hose, starting at the roof and ending on the ground floor. In order to protect the motors from this procedure they are covered with water proof tarpaulins, in addition to the drip-proof, sheet-iron covers which are permanently installed on all motors. After this, all motors are blown down with air under pressure to clean the windings of dirt or other foreign matter, which, if allowed to stay during the idle season, would accumulate an undue amount of moisture, causing mildew.

After the motors have been blown clean, the bearings are inspected through the oil slots by moving the shaft up and down with a lever, feeling the bearing lining with fingers through the oil slot to see if it is loose in the housing. If the oil has not accumulated any dirt, the oil level is brought to normal. The frame is then inspected for rust and other defects, and paint is applied where necessary. The shaft or shafts are then greased and the windings meggered. If the megger reading under these conditions shows less than 1.5 megohm, the motor is dried as will be explained later. If, after drying, and while it is still hot, the insulation resistance does not come up to the A.I.E.E. standard, a note is made on this motor record card together with other observations for reference when the repair season starts. Ordinarily, however, the motor is again connected to its lead (but without tape), and again covered with its tarpaulin.

Where any dirt accumulated in the oil of the bearings, the oil is removed

through the drain plug and the bearing thoroughly washed with gasoline or kerosene, after which a small amount of clean oil is poured in to remove the washing liquid. The bearings are then filled with clean, new oil. The motor is then turned by hand several revolutions so that the shaft becomes lubricated in its journal. Accumulation of dirt in the oil means an improperly sealed bearing, so that this is further investigated.

Ball bearings are treated a little differently, because they generally are used in dirt-tight housings. These bearings are given a shot of grease, the motors turned by hand several times to distribute the grease. Where possible these motors should be turned by hand about once a week, for it has been found that unless this is done, some of the balls will pit in minute spots, decreasing the bearing life.

After a period of about two months, and in some cases less, if these motors are meggered, it will be found that the majority read between 0 and 0.1 megohm to ground. If the motor is started in this condition, it is very likely to fail with considerable damage to the winding.

In previous years, when facilities were not available in this plant, insulation failures during the first few days of running amounted to about 10 per cent of the total number of motors operating. After this, failures were few, undoubtedly because of the evaporation of the moisture in the windings due to the heat generated in the motor. These failures caused delays in production, undue expenses in repairs, and necessitated an excessive number of spare motors.

The problem was first solved several years ago by removing all the motors to the electric shop at the end of the operating season and drying them in an electric oven. The results obtained in this way were very satisfactory, but a few failures still occurred at the start of the operating season, amounting to two per cent of the total number. Investigation revealed that the motors which had been dried in the oven first remained inactive for about about two months, during which time some accumulated sufficient moisture in the windings to have a very low insulation resistance for starting. In order to bring their resistance to a safe value the motors were kept warm for about a week before starting by applying about ten per cent voltage to the windings at standstill.

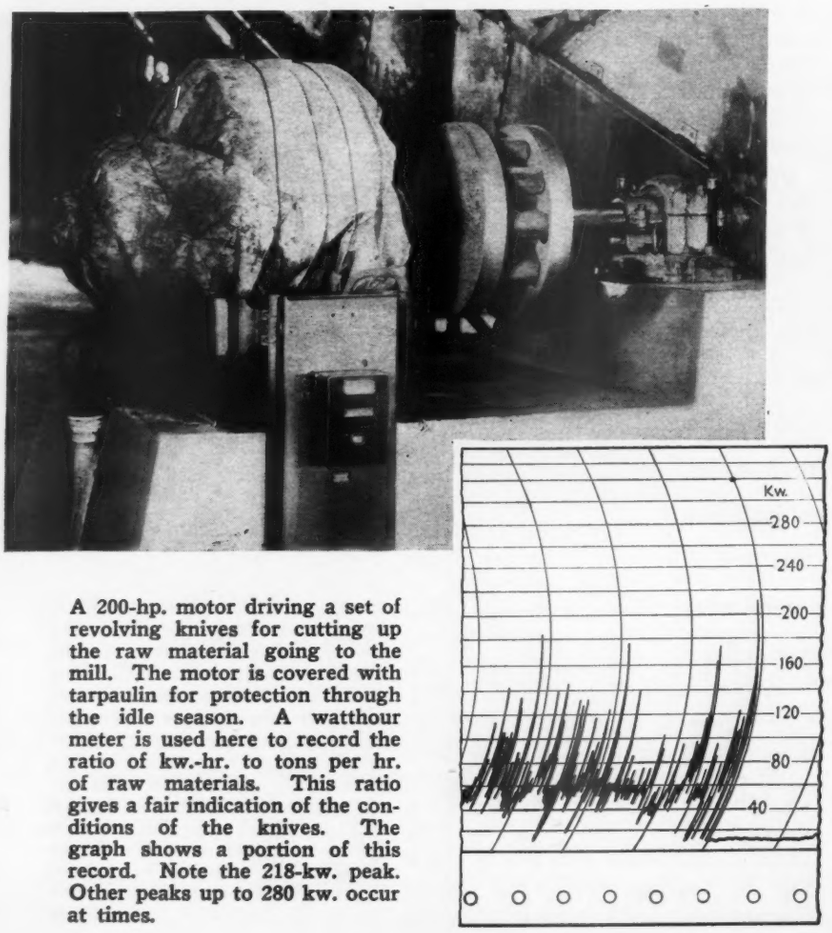
Because of the expense of this method the following procedure was adopted with a good saving in labor:

An auto-transformer was purchased which gave voltages of from 38 to 52 volts on its low-tension side by means of taps on the primary. This transformer is used on 440-volt motors. After the regular inspection and air blowing is done, as explained before, the windnigs are meggered and if found too low in insulation resistance, ten per cent voltage is applied to the windings through this transformer and the motor kept hot at about its normal operating temperature. If the insulation resistance is not normal at this temperature, after thorough drying the motor is examined in the shop.

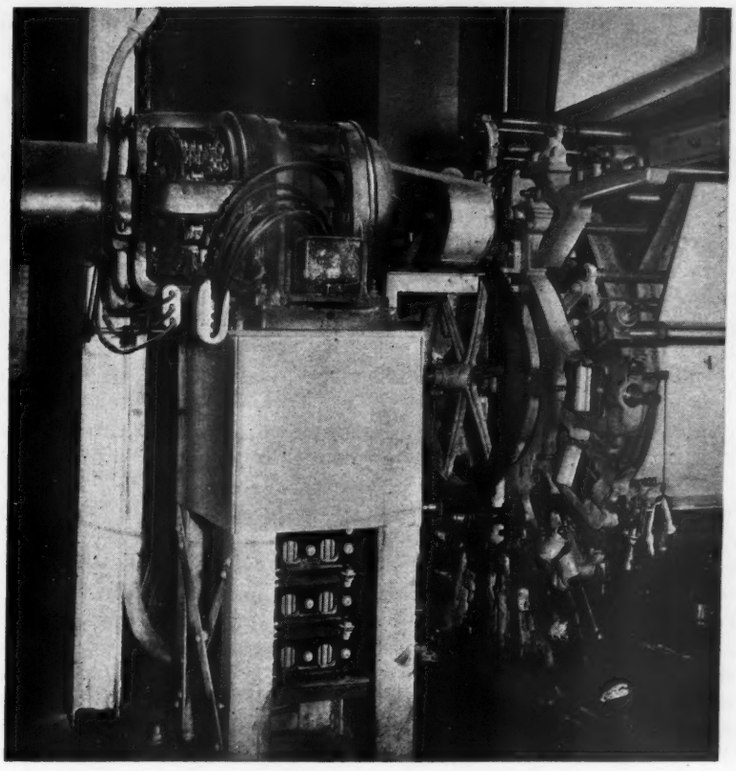
Motors with satisfactory insulation resistance are covered and allowed to stand until about two weeks before the new season starts. By means of the auto-transformer, low voltage is applied to several groups of motors at a time so as to load the transformer to its rated capacity. The low voltage is applied through the power circuits. The various starters are tied in the running position. Voltage is kept on continuously for 24 hours a day, and an electrician is kept on each watch to make rounds and to disconnect any motor which gets unduly hot, connecting it again when it cools off slightly. The insulation resistance of each motor is measured every day, and when it reaches its normal value at this temperature, the low voltage is taken off, and the leads taped.

The applied voltage should be set so that the current drawn is between ¼ and ⅓ full-load current. Slow-speed, 440-volt motors, from 500 to 720 r.p.m., require about 52 volts; 900 to 1,200 r.p.m., about 42 volts; and 1,800 to 3,600 r.p.m., about 38 volts. This difference is due to the lower impedance of the higher speed motors. For this reason also the motors are dried grouped in in accordance with their speeds.

Of course, the above procedure does not eliminate the good practice of occasionally taking the motors to the shop for a complete overhaul. This overhaul consists of disassembling the motor and thoroughly drying its windings after a thorough cleaning with air and gasoline. After drying, and while they are still hot, the windings are varnished with a good baking finishing varnish and baked thoroughly. Painting and other repairs are also done.



A 200-hp. motor driving a set of revolving knives for cutting up the raw material going to the mill. The motor is covered with tarpaulin for protection through the idle season. A watthour meter is used here to record the ratio of kw.-hr. to tons per hr. of raw materials. This ratio gives a fair indication of the conditions of the knives. The graph shows a portion of this record. Note the 218-kw. peak. Other peaks up to 280 kw. occur at times.



Adjustable-speed, brush-shifting motor, 40/10 hp., driving an eight-color printing machine and back rigging. Resistance may be cut into the stator for low speed.

Brush-Shifting A.C. Motors

An adjustable-speed, a.c. motor with the speed-load characteristics of a d.c. shunt motor finds many applications. The adjustable-speed, a.c., brush-shifting motor offers this advantage together with smooth variations in a 3 to 1 speed range.

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MANY machines require various operating speeds to obtain maximum production and efficiency. Some must run at different speeds during the operating cycle and others are designed to handle a variety of jobs, each calling for a distinct driving speed. Adjustable, a.c., brush-shifting motors; multi-speed a.c. motors; adjustable speed d.c. motors; and mechanical speed changers are available for such machines. Each type has its proper place in the field, and its characteristics must be considered before applying it.

In general, it should be determined, first, if the required horsepower increases with the speed, as in a pump, or is constant for all speeds, as in a machine tool; second, the characteristics of the load should be known for a given speed, for example, in the case of a pump, it should be determined if the load fluctuates (changes in head) or is constant (constant head). A motor on which the speed changes only slightly with load fluctuations is said to have shunt characteristics. A motor on which the speed changes with fluctuations in load is said to have series or varying speed characteristics.

Adjustable-speed (shunt characteristics) motors may be constant horsepower or constant torque, and adjustable-varying speed (series characteristics) motors also may be rated as constant horsepower or constant torque. If the horsepower requirements vary with the speed and the load may fluctuate, then an adjustable-speed, constant-torque drive is needed. On applications where a small change in speed is required and the load does not fluctuate, a wound-rotor (slip ring) induction motor can be used. The speed of this type of motor varies with the load, since it has series characteristics. It is called an adjustable-varying speed motor.

The adjustable-speed, a.c., brush-shifting motor, known as Type BTA, provides a wide speed range with an infinite number of speed points. It is designed for constant-torque operation with good efficiency over the whole speed range.

Construction

In construction this motor is similar to a wound-rotor induction motor to which has been added a commutator

and another winding in which an "adjusting" voltage is generated. This voltage, when impressed on the secondary, causes a change in speed. No external resistance is required, and the speed change can be obtained with no load.

Stator—The windings are reversed from those of the ordinary induction motor—the primary winding is in the rotor and the secondary in the stator. The phases of the secondary winding are independent, and the ends of each phase are connected to brushes on the commutator. Since the motor is designed for a constant-torque output at any speed, the secondary current is constant. A temperature overload relay is therefore placed in the secondary circuit and is mounted on the motor. The 3-hp. motor has two secondary phases, other standard motors have three, and larger motors may have more. If external resistances are put in series with each phase of the secondary, the speed will drop from that determined by the brush setting in the same manner as with the ordinary wound-rotor induction motor.

Rotor—The rotor is provided with two windings placed in the same slots, but not connected electrically. The primary winding, in the bottom of the slots, is similar to any induction motor primary. It is connected to collector rings, to which the power is applied. The use of collector rings for connection to the line limits the design to 550 volts (line) maximum. A second winding, called the adjusting winding, in the top of the slots, is connected to a commutator in the same manner as the armature of a d.c. motor. The adjusting winding, therefore, is really the secondary of a transformer, and a constant voltage at line frequency is impressed on the commutator. This voltage is low, usually below 40 volts.

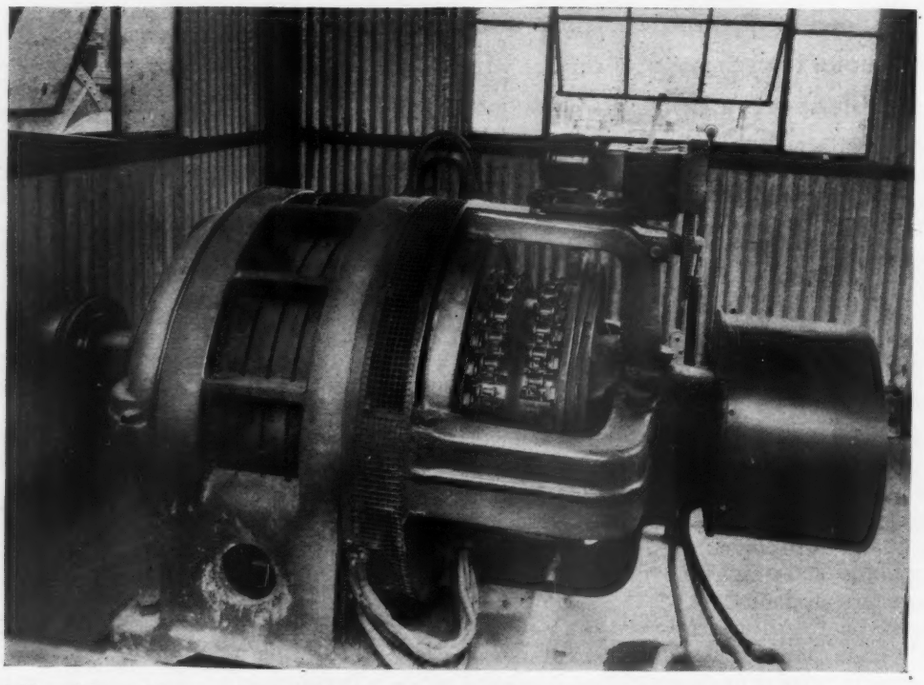
Operation—The motors are provided with two brush yokes arranged to be shifted in such a way as to vary the voltage between the brushes. In the larger motors the yokes shift so that the brushes actually pass each other. In the smaller motors the brushes do not pass mechanically, but the windings are arranged so that the effect is the same.

The voltage at the brushes obviously depends upon the number of turns of the adjusting winding included between them. If the brushes are on the same commutator bar, this voltage, or course, is zero and the secondary winding, connected to the brushes, is short-circuited. The motor then runs as an ordinary induction motor at a speed corresponding to the number of poles and to the frequency of the supply.

If the brushes are moved apart, a voltage is impressed across the secondary winding. The secondary winding must, therefore, generate a counter voltage with proper phase rotation to balance the voltage impressed upon it by the adjusting winding. The speed of the motor must change until the voltage generated by the secondary winding (as it cuts the primary flux) balances the impressed voltage with just enough difference to permit sufficient current to flow to develop the required torque. Moving the brushes apart in one direction causes the motor to run below synchronous speed, and moving them apart in the other direction causes it to run above synchronous speed.

When the commutator is stationary, the frequency of the voltage across the brushes is the same as the frequency at the commutator bars: viz., line frequency. When the rotor turns at synchronous speed, the frequency at the brushes becomes zero, even though the frequency across any two commutator bars remains that of the line. The frequency at the brushes, regardless of their position, is equal to the slip frequency in the stator. For a given setting, therefore, brush voltage is constant, but the frequency of that voltage, changing with speed, is always equal to stator frequency.

The brushes on the smaller motors are shifted by a cam which provides a means of changing the power factor as well as changing the speed. On the larger motors the brush yokes are shifted by a handwheel and gear mechanism. A pilot motor may be mounted on the motor proper and controlled from a conveniently located pushbutton station.



Adjustable-speed, a.c., brush-shifting motor, rated 150/75 horsepower, 375/75 r.p.m., driving a charging pump in an oil refinery. It is coupled to the pump through a fireproof wall. A pilot motor offers remote control of the brush-shifting mechanism.

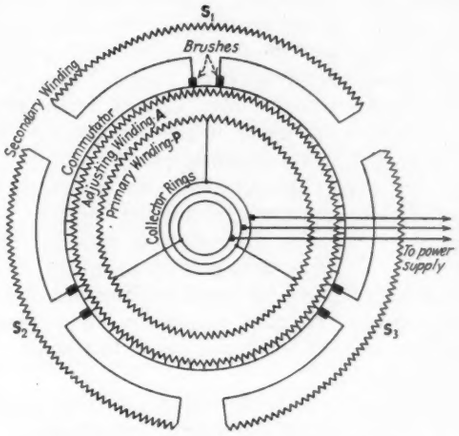
Characteristics

Type BTA motors are usually built in sizes from 3 to 50 hp. for use on 60-cycle, low-voltage, three-phase systems, although larger sizes, or motors for other frequencies and voltages or for two-phase, can be furnished. The normal speed range is 3 to 1, but this can also be varied somewhat. Standard 3-hp. to 15-hp. motors inclusive have six poles and a top speed of 1,650 r.p.m.; 25-hp. to 40-hp. motors have eight poles and a top speed of 1,250 r.p.m.; and the 50-hp. motor has ten poles and

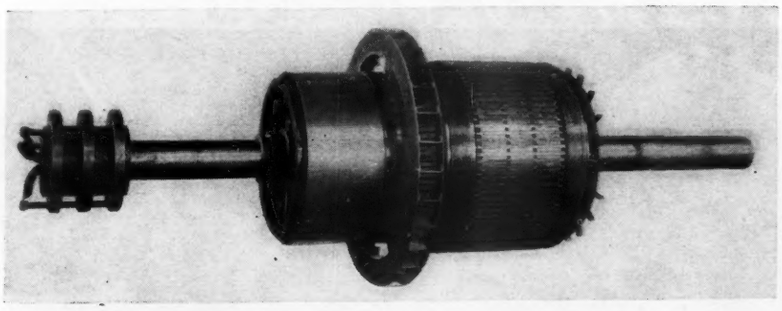
a top speed of 1,000 r.p.m. The minimum speed is ⅓ of the top speed with corresponding decrease in the horsepower rating. A creeping speed can be obtained at about ½ the rated minimum by inserting resistance in the secondary circuit. This is desirable on some applications for slow starting, and for making adjustments on the driven machine.

Starting torque, starting current, maximum torque—It is desirable to start the motor at full voltage with the brushes in the low-speed position. This provides a starting torque of at least 140 per cent of normal and as high as 200 per cent on the smaller sizes, with a starting current of only 125 to 175 per cent of the top speed current. This characteristic necessitates a minimum of starting equipment. At start the brushes may be in a high-speed position if secondary resistance is used to reduce the current and to improve the starting torque, just as with the ordinary induction motor. In the brush position for high speed, the maximum torque is more than 300 per cent on all sizes.

With a 3 to 1 speed range these motors operate from approximately 50 per cent above synchronous speed to 50 per cent below. At synchronous speed the regulation, or slip, is about the same as in a wound-rotor induction motor of the same rating. The drop in speed from no load to full load at top speed is from 5 to 10 per cent and at low speed from 15 to 25 per cent. Speed, therefore, varies only slightly with load, and the motor may be said to have shunt characteristics.



Schematic diagram of the windings in the adjustable-speed, a.c., brush-shifting motor. The primary and adjusting windings are in the same slots in the rotor. The secondary winding is in the stator, with each phase connected to brushes on the commutator.



Rotor for a 50-hp. BTA motor.

Efficiency, power factor, and regulation—Efficiency remains nearly constant over the greater part of the speed range, but is somewhat lower at low speed. The average efficiency is high as compared with that of a wound-rotor induction motor with resistance in the secondary circuit, or when compared with that of d.c. motors, if one includes the losses in conversion apparatus.

Power factor is high at high speed, usually between 90 per cent lagging and unity. It can be changed somewhat by the proper brush shift so that a well-balaced design is possible. The power factor at synchronous speed is determined by the motor characteristics when operating as an induction motor and is somewhat lower at the low speeds.

The motor will operate in either direction providing the brush mechanism is set for the desired rotation. For short periods of operation the motor may be reversed by interchanging two primary line loads.

Applications

Adjustable-speed, a.c., brush-shifting motors having shunt characteristics are suitable for applications in a wide range of industries. They are particularly adapted to the following conditions: (1) where adjustable speed with shunt characteristics is necessary and alternating-current power is the only supply; (2) where large speed range is required and where uniform speed change is desired rather than speed change in definite steps as furnished by multi-speed motors; (3) where it is desirable to operate at low speed much of the time, with the possibility also of operating at higher speeds.

This type of motor is inherently constant torque, i.e., the horsepower is directly proportional to the speed.

Textile Finishing—In the textile industry almost all finishing machines require adjustable - speed drives. These motors have proved highly successful for range drives, cloth printing machines, cloth calenders, and various individual processing machines.

On cloth-printing machine drives secondary resistors with a short-circuiting contactor are furnished, to provide a creeping speed equal to approximately one-half the minimum rated speed.

The motors also have been applied with much success to textile range drives where the cloth undergoing the finishing process passes successively through a range of two or more individually driven machines, the speed of which must be changed at times to suit operating conditions.

Knitting—One of the most recent applications of the motor is for driving full-fashioned hosiery knitting machines. Two main driving speeds are required, which are set by shifting the brushes by a hand lever. These speeds must be adjustable to take care of various knitting conditions. A third or intermediate speed is also required and must be obtained automatically during normal operation at high speed. The intermediate speed required happens to be slightly below the synchronous speed of the motor. It is obtained by short-circuiting the secondary winding through the proper resistance and allowing the motor to run as a normal wound-rotor induction motor with a little resistance in the secondary circuit.

This is easily accomplished by providing a magnetic switch, mounting it on the motor to disconnect the sec-

ondary winding from the brushes and short circuit each phase on itself through an adjustable resistance. A limit switch on the machine controls the slow-down contactor and another limit switch actuated by the brush-shifting handle prevents the contactor from operating when the brushes are in the low-speed position.

With this connection the motor provides accelerating and decelerating torque so that the change in speed both up from and down to the intermediate point is very rapid. A solenoid brake is used on this motor for quick stopping.

Other common applications of this type of motor are as follows:

Power Plants—To drive stokers, draft fans, and automatic conveyors. Stoker motors are usually hand brush-shift and are provided with 120-deg. drip covers to protect the windings and commutator from falling material. Special fan-cooled motors have been applied to conveyors in a central station boiler plant. The speed of fan motors may be controlled by hand, or else in connection with steam pressure or damper control.

Pumps, fans, compressors—Where pump pressures must be held automatically, a special control panel, incorporating a Ruggles-Klingemann regulator, is used and the brushes connected directly to the regulator.

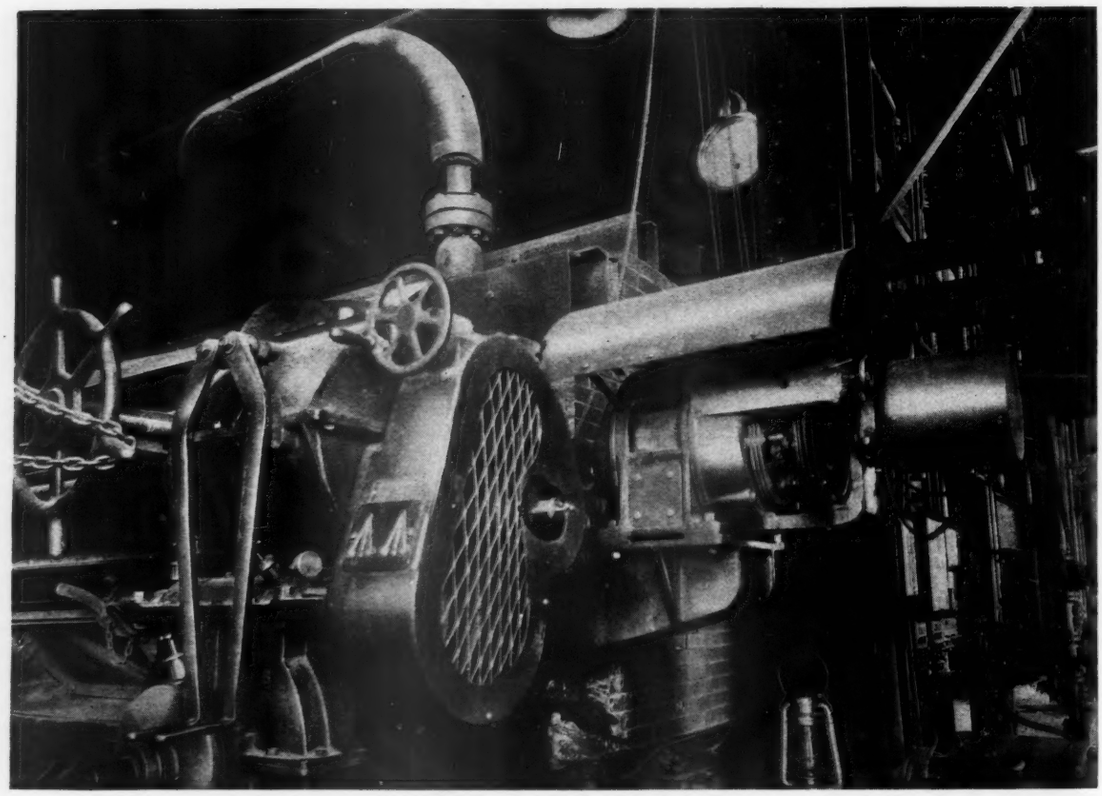
Cement Plants—To drive kilns, conveyors, and other adjustable-speed machines. On kiln drives the motors are supplied with pilot-motor brush-shifting mechanisms, for convenient speed control from the burning floor which is usually located some distance away.

Motors must be designed for an emergency starting torque of 2½ times the normal running torque. This torque is obtained by providing a special brush position which is automatically controlled to prevent extended operation at this point.

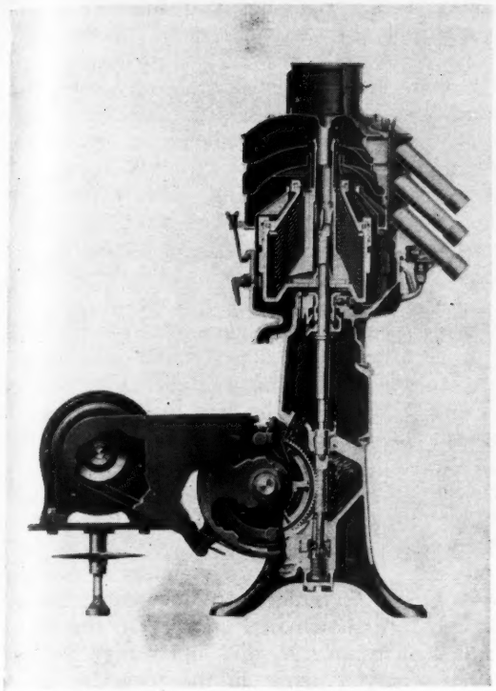
Oil—To drive charging pumps and other refinery equipment where economical operation at reduced speeds over long periods of time is essential. In one refinery there are 25 brush-shifting motors on charging pumps. Their success is based on high efficiency at all speeds, fine speed control, and ease of making speed adjustments. Pilot-motor brush-shifting mechanisms supply remote speed control from pushbutton stations. The motors are usually placed in a separate room and drive the pumps through a protective fire wall.

Paper and Printing—Where the speed range required on a paper machine is limited. Although special automatic control must be used when the motors are applied to sectional drive machines, the standard control with pilot-motor brush-shift is used for single-motor drives. A very low threading speed is usually necessary on printing presses, and a small threading motor, gear, and clutch, all mounted on a common base, are used.

Miscellaneous—In addition to the above, these motors have been applied with success to the following machines: rubber calenders, tube machines, linoleum calenders, testing machines, wire-drawing machines, steel-mill main-roll drives, aluminum foil machines, laundry flat-work ironers, and dough mixers.



Adjustable-speed motor driving a chain grate stoker. Speed is manually controlled by means of a handwheel and gear mechanism.



Courtesy *The De Laval Separator Company*

Fig. 80 — Cross-section view of the disk-type centrifugal separator and purifier. (Left)

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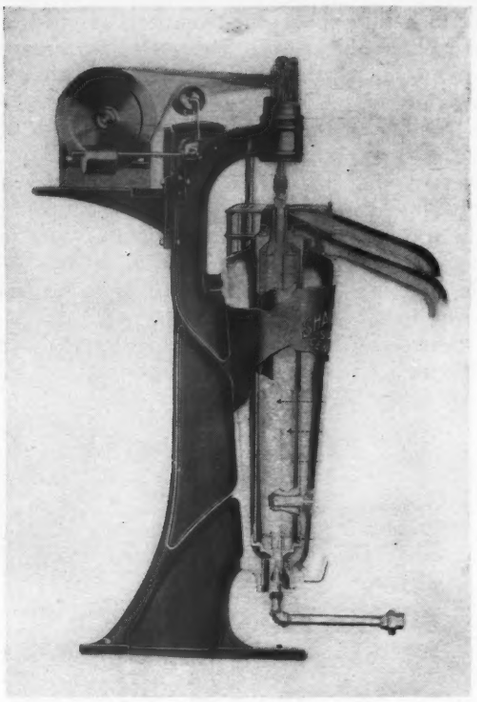
Fig. 81—A device in which oil is cleaned in a single pass through a cylinder of relatively small diameter. (Right)



Courtesy *Sharples Specialty Company*

LUBRICATING SYSTEMS

Mechanical Purifiers

Thirteenth article of a series. The next and concluding article will appear in an early issue

FRED H. LOW
Mechanical Engineer

OIL IS cleaned and purified by the use of centrifugal processes. Centrifugal clarification or separation is made possible by the same phenomenon which causes heavy impurities and liquids of different specific gravities to separate by gravity. For all practical purposes it is gravity turned sidewise and brought under control as to the degree of pressure exerted and the effectiveness of its application.

There seems to be a difference of opinion as to the laws governing this phenomenon. From one source it is argued that the amount of centrifugal force developed by any machine varies directly with the diameter of the bowl. From another, that a bullet being swung at the end of a string, in traveling, for instance, at a speed of 1,000 f.p.m., will generate a greater centrifugal force on a short string than on a long one. Regardless of this difference of opinion and the difference in the design of the machines, each type of machine performs in a very satisfactory manner. Just as separation is aided by spreading the dirty oil out in thin layers in the gravity filters already described, so is the action speeded up in the centrifugal machine.

One method of obtaining the thin layers of oil is shown in Fig. 80. Because a number of disks are used to spread the oil into thin layers this action is known as the disk method. These machines consist of a stand and outer casing for a bowl, and the collector head. The action takes place in the bowl. The drive is through a worm and gear reduction in the base, the power being supplied by a direct connected motor, a direct connected turbine, or through belt and pulley.

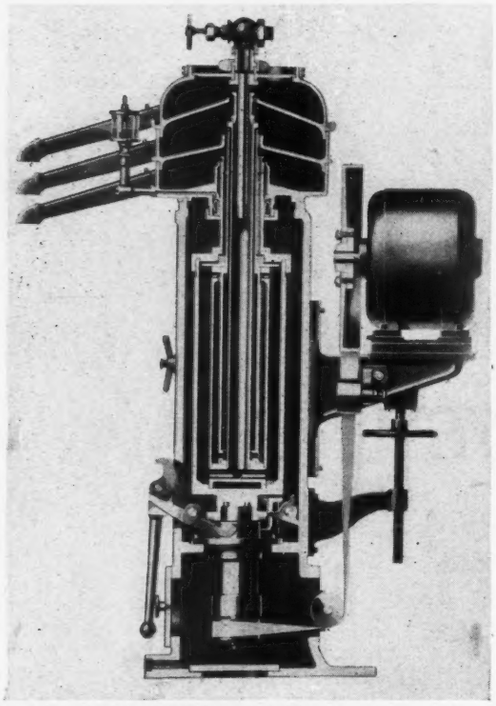
Both bowl and disks are caused to revolve at the rate of from 6,000 to 7,000 r.p.m. which develops, centrifugally, a force approximately 5,000 times that of gravity.

When the bowl attains full speed the dirty oil is run into the top at a speed equal to the capacity of the machine. This oil flows to the bottom of the bowl through the passage shown in the illustration. At the bottom of this passage the oil passes through openings to the bowl proper, where it begins to feel the effect of the centrifugal action. The weight of the column of dirty oil forces the oil in the bowl upward causing it to pass successively through the spaces between the disks, where it is spread

out in a film about one-twentieth of an inch in thickness. The water is thrown out against the lower surfaces of the disks on which it slides to the outside of the bowl.

The dirt and sludge lodge on the sides of the bowl and are removed only by dismantling and cleaning. The water, which has been thrown to the outer section, and the clean oil in the inner section, continue to rise, owing to the head of dirty oil.

Between the outer edge of the top disk and the bowl is an opening through which the water passes into the head. It then drains through the lower spout, shown to the right in the illustration.



Courtesy Positive Machinery Division The National Acme Company

Fig. 82—Through the successive passes in the cylinder the oil travels a total of 100 inches.

Near the center of the bowl is a similar opening through which the clean oil passes into the head from which it is drawn off through the center spout. The top spout is an overflow which indicates, when oil flows from it, that the dirty oil is being fed too quickly.

It will be evident from the foregoing that two distinct processes take place; namely, the dirt is removed, and the water is separated from the mixture.

Where there is an excess of dirt in the oil it is sometimes advisable to use two machines, the first having greater clearance to take care of the excess dirt, the second being of a type best suited for the removal of the remaining dirt and water.

In the centrifugal machine shown in Fig. 81 the oil is cleaned in a single pass through a cylinder of relatively small diameter. Disks are not employed. The cylinder contains a baffle which insures the rotating of the oil with that member.

Dirty oil is fed in at the bottom of the cylinder which rotates at a high speed of 15,000 r.p.m. Inside, it is thrown against the wall from the center of the cylinder, which is occupied by air. As additional oil is fed into the bowl it flows in a straight line to the top of the cylinder. In the course of its passage it is acted upon by centrifugal force. The dirt, being heavier than the oil, is deposited on the sides of the cylinder. Then comes the water, and, on the inside, the clean oil.

At the top of the cylinder are openings near the center and near the outside. As in the disk type the water is led off through the outside holes and the lower spout, while the clean oil flows through the center openings and the top spout. The dirt remains in the cylinder and must be removed by dismantling.

Because of the small diameter, the cylinder may be revolved at these high speeds without an excessive amount of material to give it strength. The cylinder weighs about 37 lb. and is easily handled for cleaning.

Another method of obtaining the desired thin layer of oil is illustrated in Fig. 82. The rotor consists of a series of cylinders, one inside the other. The dirty oil is put in at the top and is led to the bottom of the cylinder. The first pass is upward at the outside, the second pass is downward, while the third pass is upward near the center. As in the other types the dirt collects on the outside of the bowl.

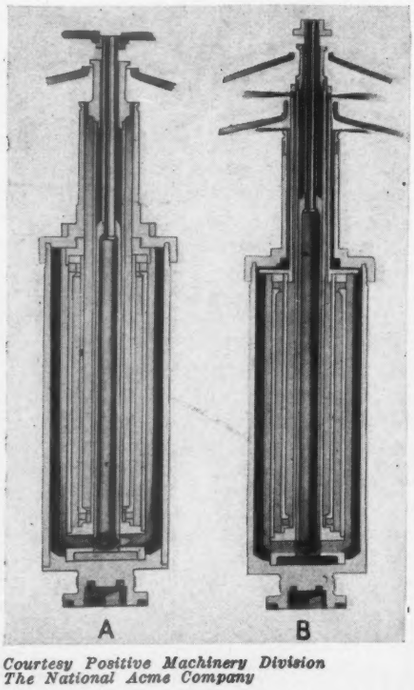
Two types of cylinders, varying in the outlets, are included. These are shown in Fig. 83. In the clarifier bowl *A*, dirt and sludge are removed, while in the separator bowl dirt, sludge, and water are extracted. The passage for water is at the top of the cylinder on the outside pass.

These machines are constructed so that the bowl may be swung into a convenient position for cleaning.

Centrifugal cleaners may be used to clean oil in batches or for continuous cleaning in connection with oil recirculating systems. If the oil is heavy better results will be obtained by heating it before it is put through the centrifuge.

When the centrifugal machine is used for continuous cleaning on a recirculating system it may be installed to handle all of the returned oil or, by means of a two tank installation, part of the returned oil may be recirculated and part passed through the cleaner to the clean tank. In this way a clean batch of oil is turned into the system every few hours depending upon the requirements of the lubricant. However, sometimes it is advisable to clean the recirculated oil in batches so that the centrifuge may be used for other purposes such as cleaning cutting oil.

While each machine is capable of handling oil under a wide variety of conditions, it is advisable always to submit your problem to the manufacturer, as the best results are obtained only when the equipment is selected for and adjusted to a given condition.



Courtesy Positive Machinery Division The National Acme Company

Fig. 83—In the clarifier bowl "A," dirt and sludge are removed; dirt, sludge, and water are extracted in the separator bowl shown as "B."

In this large shipping department lighting and painting have been used to mutual advantage. Definite painting and cleaning schedules and periodic illumination readings will prevent the good effects from being lost within a year or two.

Plant Illumination As Is

CARL HEYEL
Assistant Editor

Does your plant have definite foot-candle standards for departments? Do you maintain an interior cleaning and painting schedule? Do you realize the value of paint as an illumination tool?

WE DO not as a rule think of light in a quantitative way. And in industrial practice we are prone to forget that it is a plant service we are paying for on a definite unit basis, just as we do for gas, compressed air, and water, even though it first must be translated into lumens, and then into kilowatt-hours. This attitude no doubt is largely due to the fact that until quite recently many illumination measurement instruments required appreciable skill and care on the part of the operator. And in addition, both the MacBeth illuminometer and the familiar (and more easily manipulated) foot-candle meter with its grease-spot comparisons had the disadvantage of depending largely upon the "human equation" for their results, so that data taken with them varied widely for different individuals. But the recent introduction of an indicating illumination meter reading directly in foot-candles should give impetus to measurement of light in factories and offices.

If an engineer desires to raise the level of plant illumination he can go about it in one or perhaps both, of two ways; and he should carefully consider the economies involved. He may attack the problem from the installation angle—that is, he may spend more money on fixtures, wattage, and wiring—or he may so increase the reflective value of his walls and ceilings that the additional illumination can be obtained without touching the actual lighting installation at all, Often the first cost of painting walls, plus the yearly charges of cleaning and retouching, would be less, for a given increment of illumination, than the cost of new fixtures and a reconstructed wiring sytem, plus the yearly cost of the increased current called for by intensified illumination.

Some time ago the writer sounded out various plant engineers on the general questions of definite foot-candle standards and of the value of paint as a lighting tool. Many plants in the New York area were visited and letters embodying the questions listed below were sent to superintendents of large plants in the northeastern section of the country. The results obtained form, it is believed, an interesting "case study" of industrial illumination.

Questions put to the plant engineers were substantially uniform, and as follows:

1. Are illumination costs kept separate or are they buried in the total power and general overhead charges?
2. Are the interest and depreciation charges of the original cost of the electric light installation charged to yearly illumination costs?
3. Is a definite foot-candle standard of illumination maintained?
4. Is the cost of interior painting,

or some definite portion of it, charged to illumination?

5. Is an interior painting schedule maintained?

6. Is a definite schedule of cleaning walls, ceilings, and lighting fixtures maintained?

7. Has there been during the past year an attempt to increase the level of illumination in the plant?

8. If so, was an interior painting program considered as a means of attaining it, rather than the installation of new fixtures or an increase in the wattage of lamps used in the existing installation?

9. In the case of an increase in illumination were foot-candle readings taken before and after?

10. Has the painting of machines to facilitate operation been considered, and are quantitative data available as to the results?

These queries were sent to representative plants of the following industries: textile, machine tool, printing, automotive, and shoe. The intention was to cover plants doing close work, and to avoid so-called "process" industries, as for example laundries and certain types of food manufactories, whose operations usually are directed upon large batches of material where the action is chemical rather than mechanical, and where close supervision is not necessary.

Reviewing the questions in order, the following practices may be noted:

1. Practice as regards illumination costs varies considerably. In a great many cases the cost of current for lighting is buried with the total power charges. This procedure is unavoidable where the plant distribution system is three-phase neutral serving both light and power; but even where these services are distinct, it is often felt that separate metering is not feasible — especially since the usual practice of power companies is to charge for energy according to a sliding scale and the electricity for lighting, coming from the "top of the heap," enjoys the cheapest rate. Lamp renewal costs, of course, are available; but they are usually absorbed in a general account. In sharp contrast is the procedure followed by a large motor corporation, where separate illumination costs are kept and broken down into the three major sub-divisions of illumination power cost, lamp renewal, and direct labor. A common practice is to keep a separate kw.hr. record of illumination power and to allocate it over departments on a square foot basis.

2. The question concerning depreciation charges was put, it must be confessed, with no great expectation of affirmative replies. The reporting plants uniformly stated that no such refinement in cost segregation is followed. It does seem appropriate here, however, to point out that if a true cost analysis is desired, these charges should be considered.

3. Answers to the question concerning the maintenance of a definite foot-candle standard in the plant were most surprising. Despite the intensive educational campaign of the past few years, the field does not yet seem to appreciate that light is a mensurable commodity. Foot-candle standards have been set up in only an exceedingly small percentage of cases. Indeed, many interviews gave rise to the impression that most plant men have but a vague conception of the units used by illuminating engineers; and that there exists in this respect an immense amount of mental inertia which must be overcome before illumination maintenance is brought to a sound engineering basis.

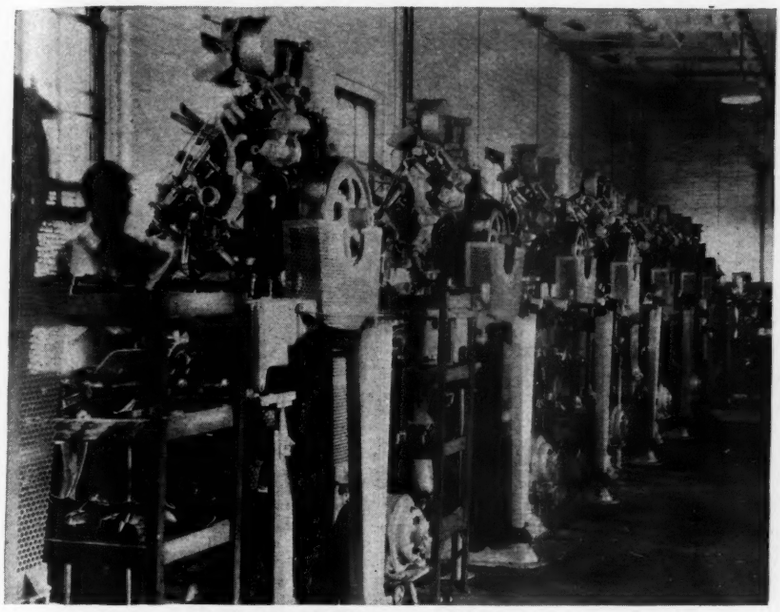
The usual procedure is to wait for the foreman of some department to complain of the light in his area before the question of added illumination is considered. Then additional wattage is supplied, or the fixtures are changed, until some amount of light satisfactory to the foreman or the machine operator affected is obtained. It was almost universally reported that no foot-candle readings are taken before or after such a change.

4. Cost of interior painting is never looked upon as an illumination charge. Invariably engineers admitted that the reflective qualities of paint are given weight when a painting program is being considered, but that the absence of any quantitative data with respect to their particular plant prevents assigning to paint any definite lighting value. This negative attitude is a direct result of the almost universal disregard of definite illumination standards in plants.

5. Interior painting schedules are not often kept. The usual procedure is to paint where and when it seems necesary. During the past year, when maintenance budgets suffered

In this packaging department article A will not go into a box that should contain article B, and percentage of breakage will not be excessive, for the management has seen fit to use light and paint to bring about a high level of illumination. Measuring their light every three months will enable them to keep this level where it belongs and to keep inefficiency from creeping into the work.

severely, many painting jobs were relegated to the future. This presages a great deal of activity along this line when appropriations once more come through. It would seem that an opportunity exists here for paint manufacturers to perform an industrial service. They can take a leaf from the power companies' book and establish "free services" for prospective users of their commodity by making illumination surveys in plants with a view to offering their product as a lighting tool.



Painting machines where shadows are annoying will bring benefits not only by reducing accidents but also by increasing illumination; and the operators will take more interest in their equipment because of pride in keeping their machines clean.

6. Definite schedules of cleaning walls and ceilings are not maintained as a rule. Cleaning lighting fixtures is given more consideration. Here again is an example of the need for definite foot-candle standards. If light readings are taken periodically, a previously set minimum of illumination will not be passed. As it is, the day-by-day diminution in lighting brought by darkened walls and dusty fixtures is so imperceptible that often decreased efficiency slips into operations unnoticed.

A case in point was found in the warehouse of a large steel plant. Several years ago the company was confronted with the necessity of increasing the illumination in one large span. A high level of illumination was demanded, because this section is used for loading steel sections upon trucks—work which must be carried on all night—and the workmen are required to read identifying numbers on the stock and to compare them with numbers on their order slips and invoices. The existing installation consisted of sixteen single-outlet fixtures spaced at equal distances high up near the ceiling, along two parallel rows 24 feet apart running the length of the 9,000-sq.ft., gabled section.

Instead of installing new fixtures, or increasing wattage, the reflective factor of the walls was increased by painting them a flat white. The walls of this span are of steel, and the purpose of painting was a much in the interests of preservation as of illumination. The roof, entirely of glass, was in such poor condition that no attempt was made to clean it because of the breakage hazard.

The walls were sprayed with one coat of white, at a cost of $450. Before the painting, 1,000-watt lamps had been used. Afterward, increased illumination was obtained, despite the fact that 500-watt lamps were installed. Thus the power consumption was cut in half. Disregarding for a moment the better lighting level, a power saving (the company pays 2.5c. per kw.hr.) of $936 a year was accomplished. This is at the conservative estimate of 15-hr., full capacity burning a day, six days a week.

But the walls were never cleaned since this painting. The engineer had no "before and after" foot-candle readings, so that he could not determine just how much good he accomplished. Obviously, good quantitative data would have enabled him to judge other illumination jobs in his plant. The fixtures, also, were never cleaned since that time. This poor practice in regard to illumination maintenance is evidenced by the fact that the advantages of the splendid job done in the beginning are now being lost as the walls are becoming soiled and the reflectors dusty.

7. As a whole, the survey indicated that there is a general tendency to raise illumination levels.

8. As to the means of securing increased illumination: there seems to be no tendency to attack the problem on a definite quantitative basis. The value of paint as a lighting tool is conceded, but just *how much* it would help in a particular instance is usually not determined, nor can it be determined, as will have appeared to the reader by this time, unless costs are given more attention.

9. In the majority of case, "before and-after" foot-candle readings are not taken. This, of cours, is a practice which cannot be defended.

10. The practice of painting machines a light color has not yet taken firm root. Most plant engineers seemed to consider that the results of such painting would not justify the money and effort involved. However, one of those who do place some importance upon the question stated the case very ably. He is the superintendent of the mechanical department in a large shoe company. He wrote that "We have considered the advisability of painting machines and have done so in certain cases where shadows were annoying. We believe that the painting of machines can be carried still further in a great many instances with beneficial results, not only from the point of view of reducing accidents, but of increasing illumination.

Conclusions

There appears to be much educational work called for in regard to plant illumination practices. The first thing required seems to be to popularize illumination terms. There is no reason why any more mystery should attach to such words as "lumen," or "foot-candle," than to "ampere" or "volt." Then, the idea

that light in the plant is a definitely mensurable commodity must be thoroughly "sold" to the field. No plant should be without an illumination meter of some sort. Schedules of cleaning and painting should be determined from the results of such readings.

Where the size of the plant warrants, illumination costs should be more clearly segregated. In this way the engineer will be able to find out whether his lighting installation is giving him his money's worth.

Much work has been done in seeking a dollars-and-cents evaluation of the benefits brought by added illumination in decreased accidents, decreased spoilage, increased efficiency, increased quality, and lower unit cost. The literature on the subject has gone into this matter very thoroughly during the past decade. Indeed, the modern tendency is to utilize foot-candle values undreamt of ten years ago. Tables showing the proper lighting levels for every sort of use can be secured from any one of the large lamp or fixture manufacturers. Plant engineers should make better use of such information now available. They should be reminded that most power companies take foot-candle readings in industrial plants and render advice on illumination matters free of charge.

It might be well, in this connection, to call attention to the increase in daylighting obtained in rooms facing a court if the court walls are light colored rather than dark. Quantitative studies of the magnitude of this increase have been made, and reflection coefficients determined for various materials used in facing buildings. With a building facing a blank wall, the data taken in this daylighting study showed that a proper building exterior can bring about an increase in illumination of 150 per cent.

Finally, the point should be emphasized that paint companies would do well to offer their prospective customers an illumination service by actually taking light readings in the plant, and then giving proper advice concerning paint as a lighting tool.

CARBON BRUSHES—A comment . . .

IN HIS article beginning on page 166 of your April issue Mr. J. S. Marcus refers to the practice of undercutting commutators by using a V-shaped cutter. I feel that the only excuse for using a V-shaped saw is to make possible an easy job of undercutting with a hand tool.

The real objection to using a V-shaped saw is that only a very small portion of the undercut slot is cleared of mica. As soon as the commutator wears to the point where the saw ceases to cut the copper, the undercut mica will become flush and a flat spot will appear. The only sure way of undercutting a commutator is to use a square saw, removing all of the mica to a depth of $\frac{3}{32}$ in. Unless this practice is followed a commutator will develop high mica within a short time, on general-purpose motors.

If Fig. 4 in this article is scaled it will be noticed that the commutator has to show only $\frac{1}{32}$-in. wear before the mica becomes flush with the copper. This will be the case if the saw keeps the bevel accurate, as shown in the drawing. However, in practice this does not occur and many of the bars will have high mica when the wear is less than $\frac{1}{64}$ in.

Personally I have had a great deal of trouble with the V-shaped types of saws which are advocated by some of the undercutting people. However, no operating man will criticize an undercutting outfit using a square saw because it is difficult to keep it in the grooves between the copper bars. In the mills of one of the large steel companies I know that undercutting with a V-shaped saw has been a complete failure, giving only about two months' service on crane motors. This length of service is much too short in view of the fact that when a commutator is undercut $\frac{3}{32}$ in. deep with a square undercut saw, as is our practice, a maximum of two years' service can be obtained.

J. M. ZIMMERMAN
Maintenance Sales Engineer
Westinghouse Electric and Manufacturing Company, Chicago, Ill.

. . . and an answer

WITH reference to Mr. Zimmerman's comments, I wish to point out that the illustration in question was merely a sketch, not a scale drawing. The amount of chamfer and angle of the V is a matter of choice and depends on many factors, including width of mica, size of bars, cleanliness of operating conditions, type of brush material, angular velocity, and so on.

The choice between V- and U-slotting is yet and probably will be for some time to come a matter of opinion. On this point Mr. R. W. Becker, Eastern Division Manager of the Ideal Commutator Dresser Company was asked for his opinion, which he has expressed in the following letter:

"We supply with our equipment either the U-saw or V-cutter. Generally, the purchaser has very definite ideas as to which he prefers and consequently we do not attempt to advise unless asked our opinion.

"Since you have asked it, I will say that we recommend the V-slot. It is my belief that it has fewer disadvantages than the U-slot, and these can be overcome readily by occasionally running the cutter over the slots. This is quickly and easily done after the machine has been undercut. So far as we know Mr. Zimmerman's objection is the only real objection to the V-slot, whereas the U-slot has several.

"First, the U-slot is not nearly so self cleaning, and consequently more readily fills with dirt, copper or carbon dust, which frequently cause considerable trouble.

"Second, unless done by a very skillful operator, it is extremely difficult to remove all the mica with a U-saw and minute fins of mica are frequently left along the sides of the slot, which although imperceptible, cause considerable trouble.

"Third, from the shop standpoint it is necessary to stock U-saws for every width of mica, whereas the V-slotter ordinarily can be used for all widths.

"Of course, in certain special cases one type of slot is preferable to the other, but for general, all-around undercutting we believe the V-slot answers best, and the greater the angle of the V the better. In other words, a 90-deg. V is preferable to the standard 50- or 60-deg. V-slot."

J. S. MARCUS
Sales Manager
Electro-Nite Carbon Company
Philadelphia, Pa.

Changing from Salient to Consequent Poles —Effect of Coil Pitch

A. C. ROE

Railway Engineering Department
Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

A REQUEST that a service engineer ascertain why a motor would not run with current flowing in all three phases revealed that the customer had a 15-hp., three-phase, 220-volt, 60-cycle, 1,800-r.p.m., four-pole, squirrel-cage induction motor, on which the winding had been reconnected from four to eight poles in an effort to reduce the speed by the use of a consequent-pole connection.

The winding had 48 slots and coils, pitch 1-and-13, and had been connected originally two-parallel-star for 220 volts, four poles, twelve groups, four coils per group. It had been reconnected series-star for eight consequent poles, but when current was applied the rotor would not turn over, and could not be made to pick up, although it could be turned freely by hand in either direction.

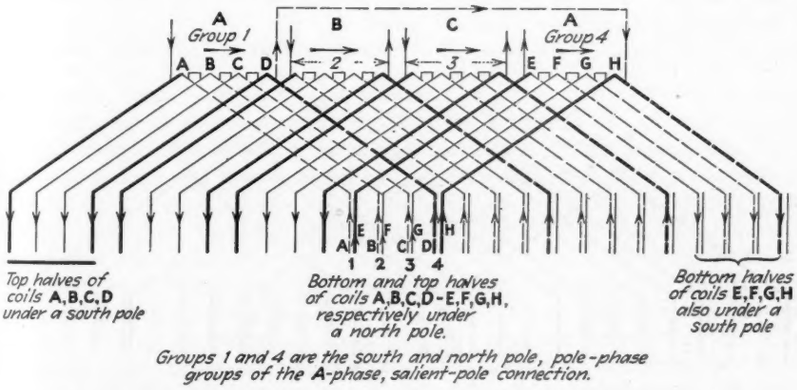

A
Group 1
B
C
A
Group 4
A B C D
2
3
E F G H
E F G H
A B C D
1 2 3 4
Top halves of coils A,B,C,D under a south pole
Bottom and top halves of coils A,B,C,D-E,F,G,H, respectively under a north pole.
Bottom halves of coils E,F,G,H also under a south pole
Groups 1 and 4 are the south and north pole, pole-phase groups of the A-phase, salient-pole connection.

Fig. 1—The top and bottom coil halves in the same slots assist each other in producing a magnetic pole.

The winding was checked for opens, reversed groups, coils, etc., and found correct in every respect.

The rotor was then removed and an attempt was made to check the polarity of the pole-phase groups by sending direct current through each phase, but practically no magnetism could be detected although the winding began to warm up, which indicated that current was flowing. The problem that was thus presented was attacked by checking off every factor that would influence a rewound or reconnected winding. Upon checking the coil pitch it was found to be $48 \div 4 = 12$ or 1-and-13, which is full or 100 per cent pitch. It was then clear that the top and bottom halves of the coils in each slot neutralized each other and although current was flowing no magnetism was developed.

Obviously the coil pitch of any winding must be considered when it is desired to utilize the consequent-pole type of connection to reduce the speed of an induction motor. Figs. 1 and 2 will help to explain the effect of the coil pitch and show why it is the deciding factor in all problems that relate to reconnecting a salient-pole winding to form a consequent-pole winding.

When a coil is wound full pitch one coil side is directly on the centre line of one pole and the other coil side is on the centre line of a pole of opposite polarity. Hence, the current induced in these two coil sides will be in opposite directions and that in one side will be added to that induced in the other coil side. In a two-layer winding with full-pitch coils the current flow in the two coil halves in the same slot will be in the same direction.

This fact is indicated in Fig. 1, which shows four pole-phase groups of four coils per group, as laid out in a four-pole, three-phase, 48-coil winding, having a pitch of 1-and-13, or full pitch. Groups *1* and *4* of the A phase are connected for salient poles, or twelve pole-phase groups set up four poles. In slots *1, 2, 3,* and *4,* the bottom halves of coils *A, B, C,* and *D,* are overlapped by the top halves of coils *E, F, G,* and *H.* The top halves of coils *A, B, C,* and *D* are under a south pole, as are also bottom halves of coils *E, F. G,* and *H.* The direction of current flow in all coil halves in slots *1, 2, 3,* and *4* is in the same direction; hence, a magnetic field will be set up and the motor should function.

Figure 2 will help to explain what happens when a full-pitch winding is reconnected to form consequent poles. The only difference between Figs. 1 and 2 is that in Fig. 2 the connection has been changed so that the polarity of all pole-phase groups is alike; thus, the polarity of group *4* to the right in Fig. 2 is opposite to that of group *4* in Fig. 1. As a result the current flow in the top conductors in all slots is opposite in direction to the current flow in the bottom conductors in the same slots, as shown for slots *1, 2, 3,* and *4* of Fig. 2. Thus, no torque will be developed and with current flowing in all phases of the stator winding the rotor can be turned by hand, but rotation will not be maintained by the current.

It will be seen that not all two- or three-phase, salient-pole, two-layer windings can be reconnected for consequent poles, if full-pitch coils are used. In basket windings with full-pitch coils the coil sides in adjacent

slots will neutralize each other, so that the same statement applies also to one coil per slot windings.

The next point to consider is what coil pitch will allow a salient-pole winding to be reconnected for consequent poles, or half speed.

The total number of slots and poles has considerable effect on the final results because they affect the chord factor, which is the deciding element. The chord factor of any a.c winding is the sine of one-half the electrical angle between the two coil sides. For a full-pitch winding the chord factor is 1; for 50 per cent coil pitch the chord factor is 0.707. These are the maximum and minimum chord factors that are ordinarily encountered in any winding.

Let us consider the effect of the chord factors of different combinations of slots and poles on salient and consequent poles, dropping one slot at a time until 50 per cent pitch is reached.

The table gives the chord factors for a winding having 36 slots and coils with 6 salient poles, and the resulting chord factor when it is connected for 12 consequent poles. The first column gives the six-pole coil pitch starting with full pitch, 1-and-7, at the top line and dropping one slot at a time until a pitch of 1-and-4 or 50 per cent pitch is reached on the bottom line. In the third column are listed the chord factors for the coil pitches given in the first column. The fourth column shows the resulting chord factors of the consequent-pole connections, based on the actual pitch as given in the first column. The last column lists the equivalent coil pitch of the consequent, twelve-pole connection.

The data given in the table are based on the fact that over-pitch has the same effect as under pitch. As shown, full pitch for the six-pole winding is 1-and-7; for twelve consequent poles the equivalent twelve-pole coil pitch, with an actual pitch of 1-and-7, would be 1-and-1, or nothing. This follows from the fact that for a 36-slot, 12-pole winding full pitch would be 3, or 1-and-4. A pitch of 1-and-7 or six slots is three slots over-pitch; therefore the resultant twelve-pole pitch is zero.

Next, consider the six-pole coil pitch of 1-and-6; the equivalent twelve-pole pitch is 1-and-2. The table shows the chord factors and equivalent pitches until 50 per cent pitch is reached for the salient-pole winding, which in this case is also equivalent to 100 per cent pitch for the consequent-pole winding.

PITCHES AND CHORD FACTORS OF 36-SLOT WINDING CONNECTED FOR 6 SALIENT AND 12 CONSEQUENT POLES

Six Salient Pole Connection			Twelve Consequent Pole Connection	
Six Pole Pitch	Per Cent Pitch	Chord Factor	Resultant Consequent Pole Chord Factor	Equivalent Pitch
1 and 7	100	1.0000	0.0000	1 and 1
1 and 6	83⅓	0.9659	0.5000	1 and 2
1 and 5	66⅔	0.8660	0.8660	1 and 3
1 and 4	50	0.707	1.0000	1 and 4

The statement was made above that over-pitch has the same effect as under-pitch. To compare chord factors we must reduce over-pitch to under-pitch and find the chord factor for the short pitch, as follows: For 36 slots, 6 poles, full pitch is 36 ÷ 6 = 6, or 1-and-7. For 12 poles, 36 slots, full pitch is 3 slots, or 1-and-4. With a pitch of 1-and-7, six poles, if the winding is reconnected for twelve consequent poles, the coils will be 6 — 3 = 3 slots over-pitch, and since full pitch for twelve poles is three slots, three slots over- or under-pitch reduces the coil pitch to zero.

Now consider the 1-and-6 pitch; this is one slot under full pitch for six poles, but for twelve consequent poles it is two slots over-pitch, or 5 — 3 = 2. Since over-pitch is equal in effect to under-pitch, 3 — 2 = 1, or the equivalent twelve-pole pitch is 1-and-2.

The 1-and-5 pitch is 6 — 4 = 2 slots under-pitch, for six poles; for twelve poles it is 4 — 3 = 1 slot over-pitch, or the equivalent twelve-consequent-pole pitch is 1-and-3. The 1-and-4 pitch is 50 per cent pitch for six poles, 36 slots, but for a twelve-pole, 36-slot winding, 1-and-4 is full or 100 per cent pitch. This leads to the rule that a salient-pole winding having 50 per cent pitch can be reconnected for consequent poles and the pitch will be 100 per cent, or full pitch.

It is now in order to consider what effect the fractional coil pitch for the smaller number of poles will have on the line voltage and rating, when a motor is reconnected for consequent poles in order to obtain half speed.

Considering a motor as a generator, when the speed is reduced one-half the generated voltage is also reduced one-half. Therefore, when changing from salient to consequent poles the speed will be halved and the number of turns in series per phase must be doubled, or if the salient-pole winding has a two-parallel connection the consequent-pole winding should have a series connection. This provision does not, however, take into consideration the effect of the chord factors for both connections.

Assume that a 220-volt, six-pole motor with a 36-slot winding connected in two-parallel, coil pitch of 1-and-6 (chord factor 0.966) is to be reconnected for twelve consequent poles. With half speed the voltage will drop to 110 volts; by using a series connection the voltage for

(Please turn to page 271)

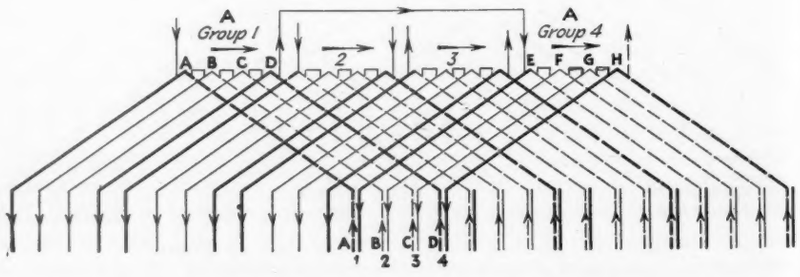
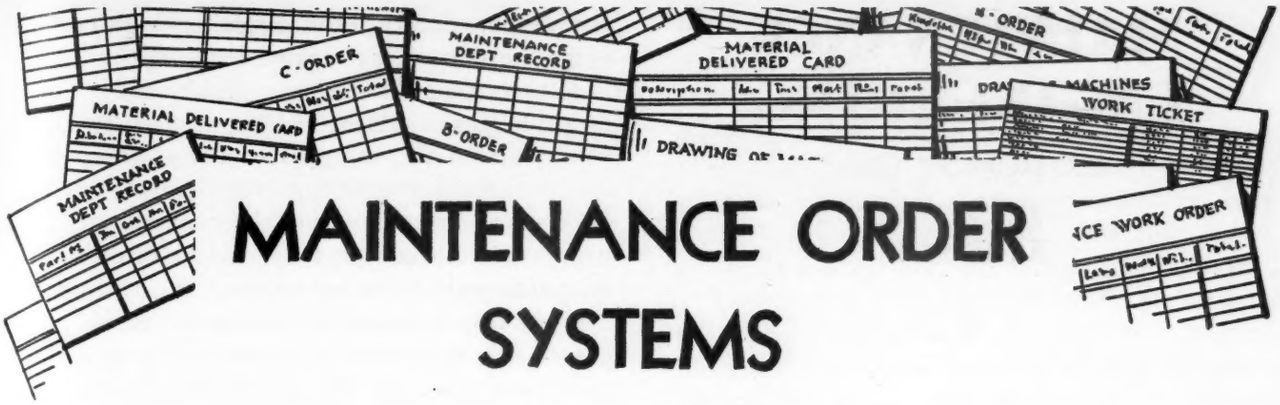


Fig. 2—Reversing the polarity of group "4" in an attempt to form eight consequent poles causes the coil halves in slots "1", "2", "3", and "4" to oppose each other.



MAINTENANCE ORDER SYSTEMS

Part VI—Where Shall the Maintenance Dollar be Spent?

G. I. ROSS

Chief Engineer, MacDonald Bros., Inc., Boston, Mass.

IN MANY companies the need for controlling maintenance expenditures before they are actually made is met by the use of two distinct types of maintenance orders. The first is for a minor maintenance job which is more or less of an emergency character and which will not entail a large monetary expenditure. The second is for a job involving large expenditures, or for one of a plant-improvement characted.

The actual dividing line between these two classes of orders varies from $5 in some plants to $100 in others. The average practice places the limit at $15 or $20 for minor maintenance jobs.

Under such a system, the minor jobs are performed upon the authority of a maintenance work order issued by the foreman of the department requesting the work to be done. It is usally issued in triplicate, the original and first carbon going to the Maintenance Department and the second carbon being retained by the originator. The maintenance foreman uses his copy for job control purposes, and sends the duplicate to the Cost Department for the distribution of costs after the job has been completed. The order for major repair work is usally designated by some special name, such as "Plant Order" or "Improvement Order," and most routines require prior estimate for it.

The estimate is prepared by the Plant Engineer's Office or by the Maintenance Supervisor's Office, and a copy or summary is sent to the originator and to the Factory Superintendent or Works Manager. In some cases copy or summary is not sent to the originator.

The need for controlling maintenance expenditures before their incurrence is widely recognized.

◆

After approval by the Factory Superintendent or Works Manager, whoever may have jurisdiction over the maintenance function, the estimate or summary is returned to the Maintenance Supervisor or Plant Engineer with notation to go ahead or to table the job. Formal work orders are then issued and the costs are collected against a charge number which has been previously reserved by the Accounting Department.

The extent of refinement at this point varies greatly. In many plants the only refinements are the issuing of separate orders to the different maintenance departments, such as millwrights, carpenters, electricians, and the like. In such cases these departments have to issue their own raw material requisitions and must determine the material required.

In other cases the Plant Engineer's Office may study the job, making out a complete bill of material necessary and placing requisitions on the Stores and Purchasing Departments for the material required. In like manner, the Plant Engineer's Office may issue separate work orders on the various departments, describing on each order the particular work which is to be done, the date on which the job is to be completed, and the next department to take up the work. In such instances, very careful studies are made as to whether the work will be performed during regular working hours or on an overtime basis, and thus it is possible for the Maintenance Supervisor to determine very accurately what labor will be required.

In the latter case, the foreman of each maintenance department usually assigns work to the individual worker and records the time expended with a simple job ticket. These tickets are sent daily to the Maintenance Supervisor's Office. The time is inscribed on the reverse side of the work order, to be drawn off as a daily total by the Timekeeping Department. In other cases, the tickets are sent directly to the Timekeeping Department and the "times" are collected individually.

No matter what the details of the routine surrounding the operation of a dual maintenance order system are, it is generally admitted that such a system permits close control over maintenance expenditures. Care must be exercised, however, to prevent obscuring large expenditures in a number of small expense orders.

It will be observed that under such a system the actual expenditures on each major expense order can be compared with the estimated expenditures, and a control thereby obtained.

Next month a system more elaborate than any treated so far in this series will be discussed.

MAINTENANCE ENGINEERING

L. C. MORROW, Editor

JUNE, 1932

■

These Are Your Tools

ONE BIG prerequisite for efficient conduct of maintenance is the knowledge of just what the job is. What are the things to be done? Just who is to do them? When must they be done?

Corning Glass is answering those questions—giving practical application to the replies (*M.E.*, March, 1932). So is Westinghouse (*Industrial Engineering,* March, 1930).

Function analysis, job analysis, personnel analysis, paper work—all are involved. Minute breakdown may be required.

And when the data are all in, and the diagnosis made, quite likely complexities will exist. The final step is simplification.

If the whole job is correctly done, if the tools scheduling, budgeting, and accounting are used, the conduct of maintenance will be quite as positive as the conduct of production—and will have been shown to yield comparable economies.

■

What Is True Maintenance Cost?

BECAUSE maintenance cost is one of the few controllable expenses in many plants under present conditions it is not surprising that much of the force of economy drives has been directed upon its reduction. Before taking action along these lines it will well pay the executive or engineer to review maintenance fundamentals.

If maintenance is to be charged with keeping all equipment in efficient, continuous operating condition, then maintenance cost in the true sense should include not only the cost of inspection, service, replacement, and repair but also the cost of production delays and accidents caused by broken-down or defective equipment, and the price of excessive depreciation. The last three items should be charged to maintenance because they are a direct result of maintenance laxity. True reduction of maintenance cost, therefore, is effected only when the sum of all these components is reduced. Such a job is difficult enough to challenge the skill of any maintenance engineer.

Where inspection, service, repair, and replacement budgets are slashed without regard for these other factors all may go well for a while, especially if the equipment previously had received good care. In consequence the maintenance engineer begins to believe that he has succeeded in eliminating unnecessary expense. In reality, however, he may have a sick plant on his hands. Because such symptoms as breakdowns, accidents, and wornout equipment do not appear until the patient is in serious condition, it will take the best efforts of the maintenance engineer and considerable expense to nurse such a plant back to health.

■

Disagree with the Boss, Maybe

"FOR WANT of a nail a shoe was lost. . ." The moral is peculiarly applicable today, when budgets are scanned with a hypercritical eye.

Most plant engineers, of course, realize that down-at-the-heel equipment represents a mortgage on the future obtained at unnecessarily usurious rates. But there are times when a "front office" order for economy can be carried out only by foregoing a necessary maintenance expenditure.

Shall a second-in-command question his superiors' wisdom when policies seem contrary to his own practical experience of plant equipment requirements? This is a knotty question often faced by the maintenance engineer when the matter of equipment purchase is up for consideration. Let him remember that constructive suggestions usually are appreciated.

Good management realizes that the men on the firing line have a practical, common-sense point of view the value of which is not to be depreciated.

■

Resist Extensive Curtailment

WHEN effected by short-sighted executives industrial retrenchment often is carried so far that it defeats its purpose. When directed at the maintenance department such curtailment often takes the misguided course of eliminating vital parts of the maintenance organization. Here is an actual example of the results of such a move.

The executives of an Eastern chemical plant decided to do away with its program of equipment inspection for preventive maintenance against the recommendations of its maintenance engineer. Because all went well for a few months

they started to congratulate themselves upon their judgment in eliminating this supposedly unnecessary expense. But their elation was short lived for, shortly afterward, several pipe supports gave way, and plant operation was paralyzed for several hours while their reduced maintenance crew worked desperately to repair the damage. The latest word is that the executives now realize that equipment inspection is essential to economical operation and are acting to bring it back.

It is to the interest of maintenance engineers to oppose such false economy vigorously for, when breakdowns occur, they are the ones who usually must shoulder the responsibility for their occurrence, repair, and the added expense that follows in their wake. No fair-minded management can resent efforts of its maintenance engineer to protect its pocketbook.

But, if management still insists on such a move after all efforts to the contrary, the maintenance engineer is justified in notifying the management that it alone must be responsible for future breakdowns.

■

Attitude Is Important

THROUGH his training and profession the average engineer is forced to deal and think almost entirely in terms of material things—concrete, steel, rows of figures. His tendency, therefore, is to regard the less tangible phases of his work as vague, perhaps over-emphasized and, at any rate, outside of his scope.

In some types of engineering work, such as pure design or research, the intangibles can be neglected without appreciable harm. But, as the engineer depends more and more upon other men for results, the intangible factor of human relations becomes of increasing importance. That human relations are of vital concern to the maintenance engineer is aptly brought out by *Maintenance Engineering's* readers recently in their discussions of this subject in the Plant Engineers' Forum.

Outstanding among the human qualities that the maintenance engineer must foster in his men for best results is an alert, protective attitude toward the equipment. Where it is obtained successfully the men will look after the equipment in the same careful and honest way as though they had bought it with their own money. Definite allocation of responsibility, payment on incentive systems, and regular meetings in which the effect on costs of careful maintenance is discussed are three ways of developing this attitude.

Let The Eyes Have It

THE National Society for the Prevention of Blindness has recently undertaken the formulation of a self-appraisal for safety engineers and other executives concerned with the conservation of vision in industry. This appraisal form, when completed, should incidentally constitute a program for 100 per cent eye protection in industry.

There are already included in the preliminary draft of the self-appraisal 55 questions. Only the plant which can answer each of these questions in the affirmative can truly be said to be doing a thorough-going job of safeguarding the sight of its employees.

Too often it is assumed in particular plants that if goggles have been provided, signs and bulletins posted, books of safety rules distributed, and orders issued to foremen concerning their responsibility for accident prevention, the whole job of eye protection has been done. If the self-appraisal form does nothing more, it will at least show how far wrong this notion is.

This appraisal—especially when it incorporates the many constructive suggestions that are being made for its improvement—should enable the individual safety engineer or plant manager to find out exactly where his property stands in comparison with the ideal in the matter of protecting the eyes of the company's employees. It should enable those responsible for accident prevention to formulate immediately a program for thorough-going eye protection.

■

YOU MAY think us insistent — we mean to be — in again referring to the series of articles on power transmission: Individual and Group Drives — Investment and Operating Cost Data, beginning in this issue.

The presentation of this series is a continuance of Maintenance Engineering's policy of placing in the hands of its readers, as rapidly as they can become familiar with their use, the tools of "engineered maintenance" — scheduling, budgeting, organization, for example. The plant survey check sheet, distributed with the March issue, is another forceful example of a powerful working tool.

Now the Drake power transmission series is added — it is one of those invaluable collections of data that heretofore no reader of any magazine could buy at any price. It is a working tool that the conscientious and efficient maintenance engineer cannot afford to be without.

MAINT-O-GRAPHS

Ways of increasing efficiency of equipment ◆ Ideas that will help plant men

News of books and events ◆ ◆ Practical solutions of plant problems

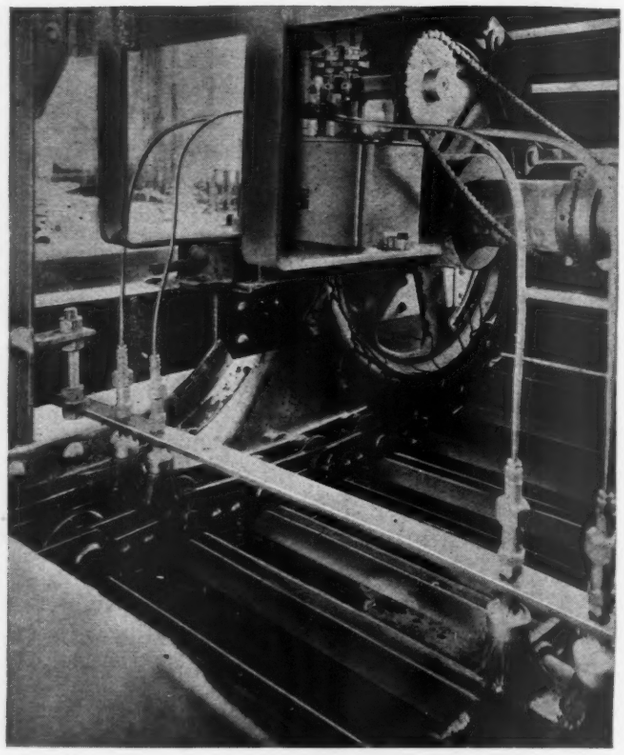
Unusual developments in apparatus design

CONTRIBUTIONS ARE WELCOME

Automatic Lubricator for Roller Chain of Apron Conveyor

ALFRED MELGARD, Mishawaka, Ind.

To understand the function of the mechanical lubricators used to oil the roller chains on the apron conveyors of a large Texas oil refinery, one must have some idea of the details of the chain parts. The roller chain shown in the photograph is of the type that has outboard rollers every other pitch. The cast iron single flanged rollers located between the side bars of the chain carry all the load on the top strand of the apron whereas the outboard rollers, mounted on every second pin, carry the load on the return strand of the apron only.



The automatic lubricator oils the roller chain of this apron conveyor more economically and positively than if the job were done by hand.

The rollers carrying the main load of the conveyor are, of course, of a larger size than the outboard rollers. They are mounted on hardened steel bushings held stationary by the side bars of the chain, whereas the outboard rollers are mounted directly on the pins.

To lubricate this type of chain by man-labor would be an uncertain and wasteful method. Therefore, all apron conveyors in this installation were equipped with the automatic lubricators.

Each lubricator is a simple device consisting of chain drive, a four-feed oil pump, and four lubrication brushes each of which is equipped with a copper feed pipe. The whole unit is mounted immediately behind the headshaft of the apron conveyor between the two conveyor sprockets; therefore it occupies only space that otherwise would be unused.

The drive from the conveyor headshaft to the oil pump is similar to the roller chain drive on an ordinary bicycle. It is direct connected and will operate the system only when the apron conveyor is running.

The oil pump can be adjusted so that the flow of oil from the reservoir can be varied. From each of the four feeds is a copper tube delivering oil to its lubricating brush. Each brush is clamped on a rigid frame so that the lubricant will be brushed off as the chain travels by.

■

Lightning Tests Leave Transformers Unharmed

SOURCE, Westinghouse Electric and Manufacturing Company

Lightning flashes of 1,500,000 volts in a demonstration test proved harmless to a de-ion equipped distribution transformer. When lightning strikes this transformer, it jumps a gap by-passing the working parts.

The tests were conducted in the Westinghouse high voltage laboratory, Sharon, Pa., where engineers geneate 3,000,000 volts, the largest man-made lightning flashes

of that kind in the world. One transformer, subjected to 175 strokes of this artificial lightning, was undamaged and unmarked at the completion of tests which reproduced in a few hours the wear and tear normally met in many years of service.

Driving Idlers Solves Conveyor Belt Problems

W. E. WARNER, Garden City, Herts, England

It is usual to drive a belt conveyor by a head pulley with the belt supported along its length by idlers. This arrangement means that all the power is applied to the belt at one point. When a belt is long and heavily loaded a large amount of driving power is necessary, and the stress in the belt will be high because all the power must be carried through the belt. These high stresses are a frequent cause of a belt wearing out or cracking at the edges.

To reduce these stresses some of a belt's idlers may be driven so that they impart power to the belt at various points along its length. It is not usual or economical to drive all the idlers of a belt. How many idlers are driven and how they are spaced should be determined by the engineer to suit the loading and length. Motor speeds must be controlled so that the surface speed of the idlers in contact with the belt is the same as the belt itself. Under these conditions the idlers will help to drive the belt. The total power taken by the drive will be the same.

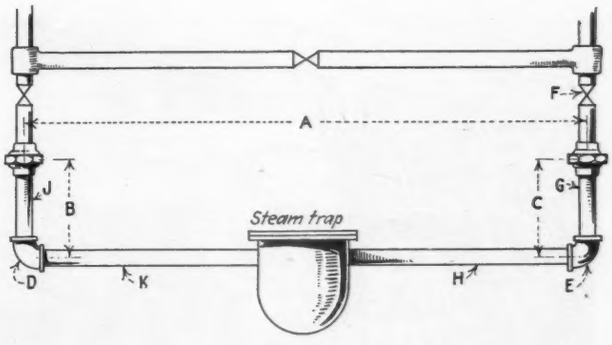
For example, assume that a certain drive takes 30 hp. with head-pulley drive only. If 5 hp. is supplied by the idlers then only 25 hp. will be needed at the head pulley. This arrangement means that the total stress in the belt will be reduced by 5 hp. This method of driving gives a more uniform distribution of stress through the belt, and thereby reduces slipping, cuts down the wear and tear on the belt, and gives a steadier drive. For a heavily loaded belt, idler driving will often prove the solution of many troubles.

Standard Connections for Steam Traps

P. F. ROGERS, Brooklyn, N. Y.

Although it is a small piece of equipment the steam trap receives special attention from most plant engineers because it forms an important protective link in the steam supply to practically every piece of steam using equipment.

At one time we had a large number of different kinds of traps in operation in our plant. The large variety complicated matters when a trap had to be changed or repaired. To alleviate this condition a plan of using a standard connection for each make of trap was decided upon. The assumption of this plan was that, with a standard connection and standard type of trap, it would



be a simple matter take out a defective trap and replace it by simply loosening and tightening two unions. The standard connections were to be added each time a trap had to be repaired.

For awhile it appeared that the scheme was working successfully, but it soon became apparent that a number of odd but very good traps that would not fit into our scheme were coming back on our hands, and we were buying a number of the newly standardized type for which we had no real need. As a result we made a survey of all sizes and makes of traps that we had in use and designed a standard connection that would receive any

of them regardless of the size, make, or type of connection. This method allowed us to keep old traps in use, replace them with the standard type, or try a new type occasionally, as desired.

The sketch shows the arrangement of connections. The distance *A* is kept constant. Distances *B* and *C* are constant for the standard trap and long enough so that most of the odd traps will fit in above the floor. Nipple *G* is always kept the same length and so is *H*, leaving any odd variations to be taken up by *J* and *K*. Suitable reducers can be installed here if the right size trap does not happen to be on hand at the moment. Where the trap is in a straight run of pipe the elbows *D* and *E* are replaced with unions keeping distance *A* the same.

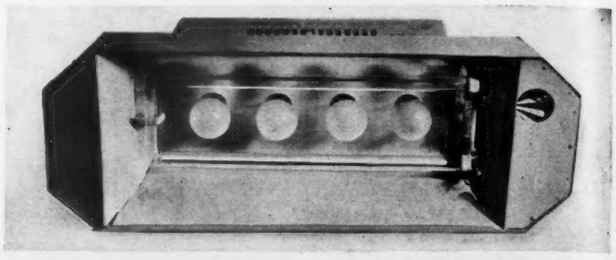
Give the trap a chance. Install it where it is easy to reach and inspect. A three-way valve *F* can be installed so that the discharge can be observed if desired. This valve shuts off the return line when opened to the atmosphere. Pipe this opening so that it will not spray the opener with hot water.

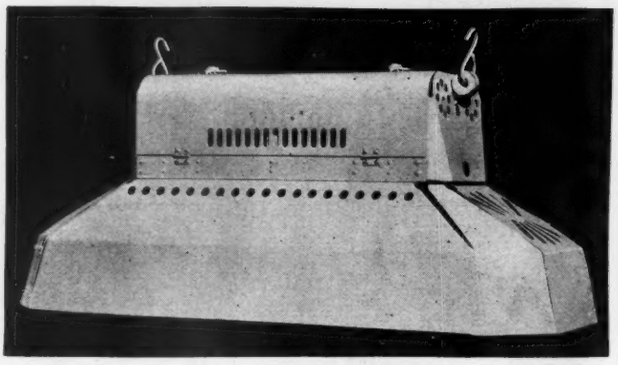
Hygienic Lighting

HERBERT CHASE, Mechanical Engineer
Forest Hills, N. Y.

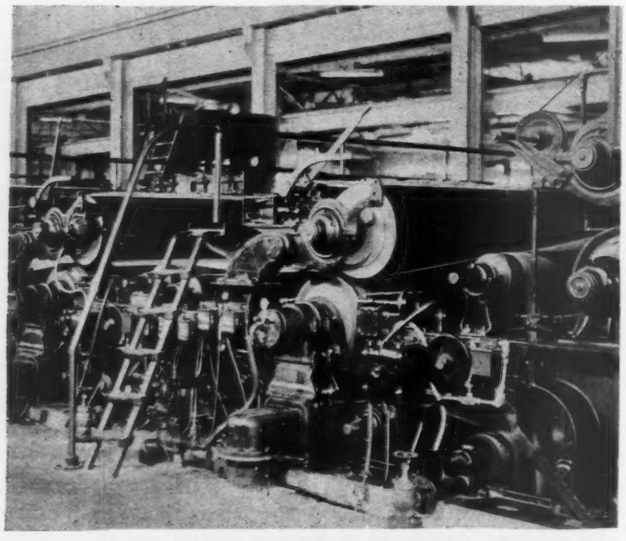
Recent developments in industrial lighting make it possible to give factory workers the benefits of exposure to ultra-violet light equivalent to that obtained in June sunlight. Tests made at Cornell University indicate that those who subject themselves to ultra-violet light regularly are much less subject to colds than those who do not receive the benefits of such exposure. It is therefore possible that the lighting system of new factories will be designed to furnish this form of light along with that required for illumination, and that many existing light installations will be converted to the new arrangement.

At present a common source of ultra-violet light commercially developed for both industrial illumination and health-giving purposes is the mercury vapor tube. This tube must be made of special glass, different from that ordinarily supplied. Plants which are already equipped with mercury vapor lighting systems have only to change to the new form of tube to secure the ultra-violet component in addition to the illumination which this source affords.





Two views of the special form of fixture used in the Simonds windowless plant. It contains a U-shaped mercury-vapor tube of special glass for transmitting the hygienic ultra-violet as well as light-giving rays, and in addition contains four 75-watt incandescent bulbs.



Interior view of the new windowless plant of the Blandin Paper Company. All light is furnished by mercury vapor sources using special glass, permitting the passage of enough ultra-violet rays to approximate June sunlight in healthful effect. The absence of glare and of all deep shadows is noteworthy.

Hygienic lighting is just as desirable in plants with many windows as it is in the modern form of windowless plant. This is because sunlight which comes through ordinary window glass has practically all the ultra-violet filtered out. Even though windows may be open, few if any workers can remain for any considerable length of time in the direct sunlight which may enter the plant.

It so happens that both the windowless plants that have attracted so much attention in recent months are provided with hygienic lighting systems. That of the Blandin Paper Company at Grand Rapids, Minn., is equipped with standard mercury-vapor units having special glass tubes; but the Simonds Saw & Steel Company, Fitchburg, Mass., employs a fixture containing a U-shaped mercury-vapor tube of special glass and four 75-watt incandescent bulbs. This unit gives a light approximating sunlight, both in color and in ultra-violet content. In the Simonds plant it is hung on 14x20 ft. centers, 16 ft. above the floor, and gives a lighting intensity of 28 foot-candles in the working plane.

Where color considerations are not important, as is true in most industrial installations, the yellow-green of mercury vapor provides a soft non-glaring light free from dark shadows.

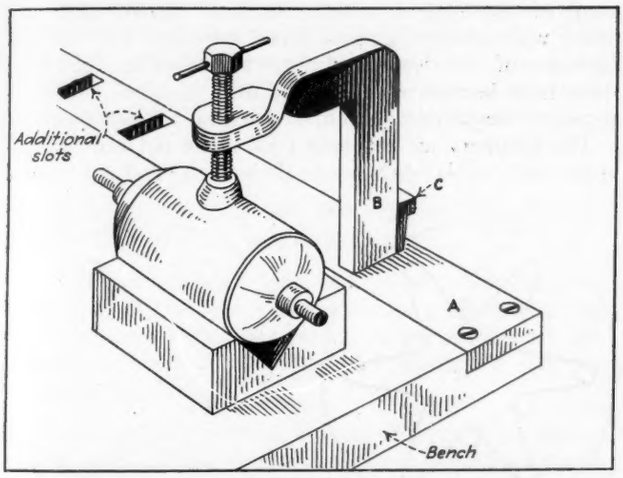
Industrial mercury vapor lamps should not be confused with the so called "sunlamps" designed for therapeutic and home use. Such lamps are not intended for factory lighting.

Bench Device Holds Small Objects Undergoing Repairs

CHAS. H. WILLEY, Penacook, N. H.

The simple device shown in the accompanying sketch represents a useful addition to the workbench tools. It has been found to be handier for holding small parts than the regular bench vise.

A bar of iron *A*, which has several slots cut in it to serve as an anchorage for the holdfast *B*, is set into the bench. The device is made of ½x2-in. cold rolled steel. It may be adjusted for various heights by means of the wedge key *C*. Its uses are obvious to any plant man.



Small objects can be held firmly on a workbench with the tool shown.

Standardized Tool Kits

SOURCE, *ASA Bulletin*

During the course of an extensive standardization program undertaken by the Detroit Edison Company, as reported by F. M. Price in the March and April issues of the *ASA Bulletin* of the American Standards Association, the canvas tool bags used by service repair men were redesigned.

Average life of these bags, a standard product of several luggage manufacturers, formerly was about six weeks. Failure almost invariably was due to one of several common causes. The handles frequently pulled from the bag, or the bottom pulled out. In the new design the handles, which formerly were riveted to the top of the frame, were changed to straps which went entirely around the bag, passing through leather cleats riveted to the sides. The bottom of the bag also was made more rugged.

Several experimental variations of this design were given actual tests under service conditions before a standard was adopted. The kit now used costs less than five per cent more than the old one. Definite figures on life are not available at this time, but the great improvement attained is demonstrated by the fact that the first standard bags were put in service about two and one-half years ago and apparently are still holding up satisfactorily.

Publications

SAFETY CODES FOR THE PREVENTION OF DUST EXPLOSIONS—Bulletin of the U. S. Bureau of Labor Statistics, No. 562. Following extensive research into the phenomena of dust explosions by the Bureau of Chemistry of the U. S. Department of Agriculture, the National Fire Protection Association organized, in January, 1932, a committee on dust explosion hazards charged with the preparation of recommended regulations for the prevention of fires and explosions in structures subject to this hazard. The regulations prepared form the basis of the bulletin and were adapted and published as the recommended regulations of the National Fire Protection Association. The standards were also adopted by the National Board of Fire Underwriters.

Copies may be obtained from the Superintendent of Documents, Washington, D. C. The price is 15 cents.

INDUSTRY PROVIDES FOR USE OF ELECTRICAL CODE—The March 22 *ASA* (American Standards Association) *Bulletin* reports that a resolution

providing for the use of the National Electrical Code (C1–1931) was adopted recently at a trade practice conference of the electrical contracting industry held under the auspices of the Federal Trade Commission. The resolution reads as follows:

"In electrical installations in territories where no governmental laws, rules, or regulations prevail the National Electrical Code, approved by the American Standards Association, provides the proper regulations."

MANUAL OF ELECTRIC ARC WELDING—This manual, edited by E. H. Hubert, formerly Assistant Editor of *Industrial Engineer* and *Electrical World,* should prove of great practical value to welding operators and engineers, designers, and many executives.

Fundamentals are ably presented. Illustrations and photographs help make the processes and practical applications clear. Of special interest is the "Training Course for Operators" to which the last third of the book is devoted.

Publisher is the McGraw-Hill Book Company, Inc., 330 West 42d St., New York, N. Y., the price is $2.

Convertible Roller Conveyor

SOURCE, Western Electric Company

By pressing a pushbutton the roller conveyor illustrated can be transformed from the gravity type into the live-roller type. Two motors operate the mechanism. One motor actuates the belt that drives the rolls, and the other raises and lowers the frame containing the driving belt.

The conveyor is converted from the gravity to the power-driven type as follows: Pressure on a single pushbutton starts both motors. When the belt frame reaches the position where the belt engages the rollers a limit switch shuts off the elevating motor, but the motor driving the belt and rolls continues to run. The unit has now been converted into a live roller conveyor. Pressure on a second pushbutton stops the motor driving the belt, and the second motor starts to lower the frame. When this motor has lowered the frame to its lower level it is stopped by a limit switch, and the unit again is a gravity roller conveyor.

Belting Disks Simplify Coupling Maintenance

F. E. GOODING, Chicago, Ill.

The flexible couplings used in a certain paper mill were of the type in which the inner flange faces are fitted with projecting pins laced together with a belt. Because of the wet conditions surrounding the drive these belts became water soaked and stretched, and consequently required frequent shortening and renewal.

The maintenance engineer took some old canvas conveyor belt (rubber belt would do as well) and cut several

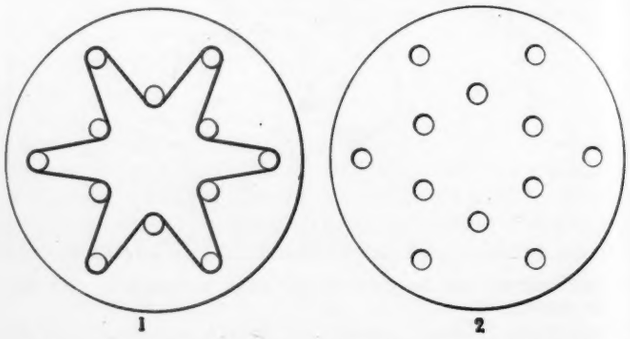


Fig. 1 shows how the belt is entwined on pins projecting from flanges of original flexible coupling. Six pins project from each flange. Fig. 2 shows the disk of conveyor belt punched with holes spaced to suit the projecting pins.

disks of a diameter equal to that of the flanges. He then cut holes in these disks to match the projecting pins. A sufficient number of disks were used to build up a laminated disk equal in thickness to the width of the interlaced belt formerly used.

To install these disks in the coupling it was necessary to offset the motor far enough to insert the disks. So far, none of the disks have shown evidence of wear, and I believe that they will last as long as the rest of the equipment.

On installations where the intertwined belt in the coupling serves as a safety link or breaking strip in case the equipment chokes, these disks should not be used.

A new question is presented each month, and our readers' answers to previous questions are published. Write down your opinions and send them to the editor. Answers published will be paid for

PLANT ENGINEERS' FORUM

How Measure the Efficiency of the Maintenance Department?

While walking home from his company's annual banquet Frank Fulleger is hailed by a voice which he immediately recognizes as belonging to his friend and adviser, George Shipman. Let's listen in on their conversation as they head homeward together.

* * *

"I'm surprised to see you walking, Frank. Car broken down or are you economizing?"

"Neither, George. Just been to our plant banquet. Several of the boys offered to drive me home, but I told them I'd rather walk. After all the hot air that was thrown around by the speakers I felt the need to cool off."

"Not so bad as that, I hope, Frank. You had a free meal, didn't you? And, may I add, in these days that's something!"

"I don't want you to think me an ingrate, George. The food was fine and it was great to see the bunch. Perhaps the reason for my low temperature is that I feel a bit neglected."

"How come?"

"Well, after several of the usual pep talks, our president got down to cases on the work of the different department heads. Most of the glory went to Jack Burns, our sales manager, and Bob Newman, our production manager. Not many plants are making their sales quotas in these days, but Jack did it. Although it isn't unusual to see production costs go down in the last few years, Bob has cut ours to a surprising figure. All this time your friend Frank sat by unnoticed.

"I don't want you to misunderstand me. I say more power to Jack and Bob, they've done darned good jobs and deserve all the praise that they've received. But I do think I can say with pardonable pride that I've done just as good a job as they have. The trouble is there is no definite way that I can prove it—no yardstick like the sales manager's quota and the production manager's unit cost."

"For once I think you have a real grievance, Frank. I've been thinking about the same thing lately. Been trying to figure it out by setting up a budget or quota of maintenance costs for my maintenance engineer to shoot at."

"But you know as well as I do, George, that low maintenance costs alone are no proof of a good maintenance job, unless they include the costs of production delays and accidents caused by defective or broken down equipment, as well as of excessive depreciation."

"That's the tough part of the job, Frank—working out something that will take in all the factors. Maybe I'm on the wrong track or maybe I just need to give it more thought. You'd better keep it in your subconscious, too. . . . And here we are at the corner. I'm afraid you'll have to walk the rest of the way home alone because it's way past my bed time. Good night."

* * *

Few readers will deny that there is a real need for some sort of an efficiency yardstick for the maintenance department. Contributions discussing actual or proposed methods for attaining this end are welcome.

Can the performance or efficiency of the maintenance department be measured by practicable procedure? If so, how? If not, why not?

Should the efficiency be determined on a cost basis?

Readers' Answers to Previous Questions

What Human Qualities for Maintenance Men?

(Question presented in the May issue)

HUMAN qualities are of primary importance in maintenance work. Thanks to the maintenance man, production customarily goes along in the usual way without interruption. But, when something goes wrong, the siren screams and there's a hurry call for the maintenance crew. "Fix it, and fix it quick!" demands the production man. Then and there the maintenance man must bring to the job not only knowledge, skill, and tools but also a plentiful supply of tact, patience, and loyalty.

Because men's nerves are on edge in times of stress it is not uncommon for the harassed production man to vent his spleen on the very ones who are doing their utmost to correct the trouble. In such a crisis a maintenance man lacking in patience and loyalty will give as good as he gets. The result is a wordy battle that not only delays completion of the job but also may leave scars that never heal.

Look first, therefore, for human qualities in a maintenance man. Knowledge and skill are important, of course, but they are found more commonly than sympathetic understanding of the other man's viewpoint. When you find a man with tact and loyalty you can well afford to help him increase his knowledge and develop his skill.

E. G. GREEN, *Plant Engineer*
Libbey-Owens-Ford Glass Company
Charleston, W. Va.

REGARDLESS of forethought and vigilance, accidents do happen and machines will break down. The speed with which the maintenance man rectifies a failure is the yardstick by which his efficiency is measured. His speed depends upon his originality and resourcefulness when working under pressure.

A maintenance man should be able to put all thought of individual glory from his mind and be open to suggestions and criticisms. His primary object is to cooperate and subordinate his services in the interest of uninterrupted production. If he keeps these few qualifications in mind he cannot help but be recognized as successful in his occupation.

CARL R. METZGER, *Foreman, Maintenance Department*
Franklin Pottery, Lansdale, Pa.

THE most essential human quality for a maintenance man is patience. When trouble arrives—like the little boy who complained that when anything went wrong the teacher thought of his name first—so, in industry, does the name of the maintenance man first come to mind. Recognition of this fact by the maintenance man himself will temper him with understanding and tolerance and will give to him that all-important virtue—patience.

This quality of patience will cover a multitude of sins, as well as allow the maintenance man to make allowances for human and mechanical defects. It will give him the faculty of understanding the other man's viewpoint and, in so doing, it will allow him to proceed in sympathy with his co-workers.

Patience will make him tactful, it will give him that important virtue of resourcefulness and, finally, patience will bring him the good will and respect of his colleagues. When they see his calm, careful, calculating steps bring an emergency to a satisfactory completion, their regard for him will mount as they observe the patience displayed.

Sincerity, honesty, loyalty, integrity, and ability are needed no more in maintenance men than they are needed in any person who expects to succeed on any job—they are inherent essentials

C. S. STEVENSON, *Operating Manager*
Hall Bros., Inc., Kansas City, Mo.

THE OPERATION of the maintenance department requires a minimum of friction and a maximum of intelligent cooperation if the needs of the company are to be administered efficiently. It is here that the human side of the business is a vital factor.

Most maintenance foremen realize that the job of getting results is one requiring patient understanding, patient study, and patient work with the men themselves.

People are always happy doing interesting work for people in whom they have confidence. The man who feels that he is being squarely treated will do more and better work than the other man who is not so happily situated in his mental attitude toward his work. The head of the department should point out the necessity of seeing the other man's viewpoint to maintenance foremen who have failed to cooperate. No work has been devised that is so monotonous or so highly repetitive that it offers no opportunity for development to the worker, provided he has confidence in his immediate superior. Men respond readily to a square deal, sympathy, and commendation from their superior. They will give their energy, skill, and loyalty to such a man.

HARRY KAUFMAN, *Engineering Department*
Naval Aircraft Factory, Philadelphia, Pa.

AVOIDANCE of friction and antagonism among men in responsible positions is one of the requisites of plant success. When I find a man who irritates the very men whom he ought to cultivate I make an investigation to find out just what causes the trouble. When I have determined the cause impartially I make it plainly known that harmony must exist and instruct the offending one as to how correct human relations can be attained.

In the first place I insist that there shall be no tattle tale in my outfit—no going over each others' heads for a supposedly advantageous interview. If I find a maintenance man who is inclined to assume unwarranted authority in the hope of making the big boss think he is smarter than his immediate superior, I have a heart to heart talk with him and make him understand that he is only spoiling his chances of success and hurting the organization.

Most foremen who are worthy of the title know that tact and a pleasant disposition with a decent regard for the other fellow's feelings are essential for cooperation and success. A maintenance man especially is in need of human qualities if he is to do a successful job. Outstanding among these qualities are tact, seriousness, honesty of purpose, skill, sound judgment, and courage. It is through these human qualities that success comes in almost any endeavor.

CHAS. H. WILLEY, *Superintendent of Manufacture*
Hoyt Electrical Instrument Works
Penacook, N. H.

Regular Foremen's Meetings?

(Question presented in the April issue)

COMPANIES of all sorts are coming to realize that, for the highest plant efficiency, there must be a direct relationship between the employer and the workmen. There is no better way of achieving this end than to have regular foremen's meetings. There should be no question about whether the meetings should take place on company time. If the meetings are held outside of regular working hours, the employer unconsciously breeds the antagonism of his workmen.

I find that best results are obtained where the employers are present, but remain in the background and allow the foremen to run the meeting as they see fit. This method makes the foremen feel that they are being trusted.

The meetings should be held once a week for about an hour, with the privilege of calling a special meeting whenever necessary. Questions in regard to plant tactics, efficiency, and means of causing greater correlation between the different groups should be discussed. Complaints of the workmen should be brought to the meetings by their respective foremen.

The only disadvantage of foremen's meetings that we encountered was that of replacing the foremen for the time of the meetings, but we solved this problem by giving a different workman a chance each week to take charge of the department. We found that this method has worked out satisfactorily.

The advantages of such meetings are too numerous to mention completely, but a few of the important ones are a better feeling between the employer and his workers; greater efficiency between the groups; and clearer understanding of just what was expected of each group.

WILLIAM HERMAN, *Superintendent*
Tanenbaum & Sons Oil Company
Cleveland, Ohio

ALTHOUGH a plant may have only a few foremen, numerous problems will arise among them. If not settled quickly these differences will lead to disorganization and friction. When settled through the superintendent's office, they often cause red tape and a feeling that the other fellow is getting himself in solid with the boss by carrying stories. When a problem involves a number of foremen it is difficult, if not impossible, to solve it without bringing all the foremen together at one time. In many cases where meetings are not held the "buck" is shuttled from one foreman to another until someone gets into trouble. Situations of this sort, which arise more often than management usually realizes, are part of the proof that foremen's meetings should be held.

Because these meetings are as important to the company as any other part of the foremen's work, they should be held on company time. Furthermore, records or blueprints, which would not be available after quitting time, might be needed. Or it might be necessary to consult individuals who do not usually attend the meetings.

It is best for the management to conduct the meetings in an informal manner because the advice and guidance of someone in authority probably will be needed to conduct the gatherings in speedy and orderly fashion. In addition, the meetings offer management the quickest means of finding the adjustments in plant routine that continually must be made to keep things running smoothly and efficiently.

BERNARD SHEREFF, *Engineer, Standards Department*
American Hard Rubber Company, Butler, N. J.

IT WAS during the hectic World War days, with production schedules six months behind, that we first decided to have daily foremen's meetings from 11:30 a.m. until noon.

As production manager I was in charge of the meetings. The principal object in holding meetings was to help the foremen to realize the inter-dependence of departments and the necessity for close cooperation and team work, and thus eliminate the practice of "buck-passing" so prevalent at that time.

Foremen were required to report daily the reasons why production schedules could not be maintained as set up by the planning department. Troubles were thrashed out on the spot, and helpful suggestions were made which did much to speed up production.

After the War the production pressure eased, and gradually not only production problems were discussed, but subjects of general interest pertaining to efficient plant housekeeping were taken up. A program committee was appointed the duty of which was to draw up a list of suitable subjects and to assign them to those best qualified to introduce them. Any man had the privilege to suggest subjects that he would like to have discussed. A superintendent presided at these meetings who had the tact and ability to get others to talk and express their opinions freely.

Some time later I became connected with another firm in which foremen's meetings already were being held every Saturday from noon until 1:00 o'clock when the plant closed down. The general manager was in charge of these meetings. At the first meeting I was impressed with its formal character and with the evident lack of interest on the part of the men. This general manager did most of the talking; he lectured his audience about their manifold shortcomings and gave instructions as to what had to be done to improve conditions. The men listened respectfully but without enthusiasm. They were afraid to express their opinions in the meeting, but they talked plenty afterward. Fortunately this general manager became more interested in golf than in foremen's meetings, and later delegated the job to the general superintendent.

I suggested a course in foremanship at this plant and a suitable course was selected. The men received the lessons in advance and were expected to study them and be prepared to answer the questions at the end of

each lesson. Lesson material was applied to actual plant conditions in order to make the subject matter of practical value. The change of attitude of the men resulting from this study was remarkable. In general the course produced an improved type of foremanship.

In regard to what should be discussed, systematically arranged subjects dealing in a simple way with the fundamental principles of factory organization and management, costs and cost control, production, maintenance, waste, and accident prevention all are of vital importance and interest to the foreman who takes his job seriously.

G. B. VAN HEYNINGEN
Mechanical Superintendent
National Tea Company, Chicago, Ill.

WE HAVE found it advisable to call our foremen together occasionally to discuss problems, new jobs, new materials, and new methods. The meetings are called on the firm's time and are arranged to interfere least with our program.

The Building Superintendent calls the meetings, and they are held in his office. Although he leads the meetings informally every man is given an opportunity to voice his opinion. It is surprising how many interpretations there can be of the same orders. Questions often have been settled as to which crew is responsible for certain work.

Our foremen also attend a school called the "Foreman Safety School," which is held under the auspices of the Milwaukee Association of Commerce. At these meetings the speakers generally are leaders in their respective fields. These meetings are held at night, and the men attend them on their own time.

A day or two after some of the safety sessions a meeting is called at the plant, at which the parts that pertain to our own plant are discussed. These meetings have no regular schedule and are called only when there is a subject of mutual interest. This prevents them from becoming commonplace and monotonous.

From our experience the question of foremen's meetings can be summed up as follows: Have meetings; have them on the firm's time; have them when there is something of importance and make them interesting; but do not have them too often or they will lose their appeal.

L. H. DICKELMAN, *Building Superintendent*
Ed. Schuster & Company, Inc.
Milwaukee, Wis.

THERE is no doubt in my mind but that a great deal of good is derived from holding foremen's meetings. If a company is organized so that routing and scheduling are the determining factors of a smooth flow of production rather than the foreman's presence, I believe that his absence for two or more hours in no degree would detract from his department's efficiency, If it is necessary that every foreman be present every moment of the day in his department, I believe that there is something wrong with such an organization.

I believe that the meetings should be conducted by the foremen themselves, with a member of the management present in an advisory capacity to suggest problems for discussion or to convey a message from the management to the foremen. Especially should messages be delivered and problems introduced that can be settled adequately only by active discussion of the foremen. Thus, should a schedule of increased production be desired, a message to that effect should be presented to the foremen by a member of the management. Views as to what stands in the way of the operation of the new schedule and what is necessary before it can go into effect can be advanced. And, should one or more of the foremen foresee difficulty, he can make it known at that time so that, when the new schedule goes into effect, a smooth flow of increased production can be obtained.

With one who is a natural born leader as chairman of the meetings, discussions and solutions of problems can be brought to rapid and satisfactory conclusions. To hold meetings more frequently than once or twice a month would only detract from their purpose, making them appear as a social affair rather than a purely business gathering for the discussion of problems concerning the welfare of the individual departments and the concern as a whole.

Important problems such as safety practices, bettering of relations between management and the worker, suggestions or ideas for the betterment of production methods, and suggestions for methods of training of workers, should be discussed. Last but not least, the meetings should act as a conference method of training for the foremen themselves.

DANIEL H. FRUCHTMAN, *Foreman*
Pacent Electric Manufacturing Company
New York, N. Y.

Should Maintenance Methods Be Given Publicity?

(Question presented in the February issue)

ALTHOUGH there are two sides to this discussion I do not see what harm can come from helping fellow maintenance men solve special problems. It seems to me that an exchange of ideas on bothersome problems should benefit all companies operating along the same lines and having similar equipment. Often a method used in one plant will not fit in another in all details but will have to be changed to suit its new conditions.

Maintenance men often find by exchange of ideas that they have been doing some routine jobs for years in the same old way which could have been simplified long ago by adopting the methods used in other plants. The chances are that many methods thought the sole and private possessions of certain companies have been used for years by other companies. I do not believe that in ordinary maintenance work the variation in maintenance costs due to the use of different methods could possibly be great enough to affect to any extent the price of the product in competitive bidding.

Of course there are certain production processes that should be kept secret. Special machinery and formulas developed for these purposes should be protected by patents.

In my opinion maintenance methods, such as are used for routine and special breakdown repairs, and inspection methods do not entail secrecy.

GRADY H. EMERSON, *Chief Electrician*
Reed Brothers Stone Company
Birmingham, Ala.

QUESTIONS and ANSWERS

Lubrication of Ball and Roller Bearings

Lubrication of 60 motors and generators fitted with ball or roller bearings is giving us trouble. These machines are rated from 1- to 250-hp. and are used on equipment ranging from gasoline-electric locomotives to small sump pumps. Careful reading of manufacturers' bulletins has failed to give me the answer to these questions: (1) How much lubricant should be kept in a ball bearing? (2) What kind of lubricant should be used? (3) How can I tell when the proper amount of lubricant is being used? We use light grease and in order to prevent it from creeping out along the shaft a small hole has been drilled in each bearing level with the bottom of the shaft. In spite of this precaution a great deal of trouble is caused by grease getting on the commutator and windings. How can I demonstrate to the oilers and operators when enough grease, but not too much, has been put in? J.R.C.

Peoria, Ill.

■

Why Is Oil Injurious to Motor Windings?

It is frequently stated that oil is very injurious to motor windings. Why should this be true in view of the fact that transformer and other types of coils will give years of service when permanently immersed in oil? Are transformer coils treated with a different kind of varnish than is used on motor windings? Or are lubricating and insulating oils so different in character that one will attack insulating varnish, whereas the other will not? G.F.K.

Grand Rapids, Mich.

■

Peventing Rise in Voltage on Power Lines

Our lighting circuits are fed from the 220-volt, three-phase power lines. At times just as we cut off the power from our motors the voltage will jump to 260 or 270; hence, we are forced to use 135-volt lamps in order to avoid frequent burnouts. Does this excessive rise in voltage indicate any defects in the power company's equipment, or does the fault lie in our plant?

Springfield, Mo. W. L.

Please submit answers promptly. We expect to publish no answers later than the second issue after the appearance of the question. Selection will be made on the basis of quality, but answers first received have the best chance of being used

■

Removing Oil from Concrete Floor

A portion of our plant that was formerly used for manufacturing has been converted into offices. It is planned to paint the concrete floor, but in many places it is soaked with oil and I am afraid that in these places the paint will not dry well or adhere. Washing with gasoline has been tried and seems to remove the oil from the surface of the concrete, but after a time the oil below the surface works its way up again. I should like to know whether there is any treatment I can use that will remove enough of the oil to prevent trouble when the floor is painted? J.B.L.

Brooklyn, N. Y.

THE CHOICE of a method of cleaning the concrete floor in question will depend upon the condition of the surface. If the surface was well troweled when laid, the oil cannot penetrate as deeply as though it were rough and porous. The following method, which is extensively used for cleaning garage floors, is recommended:

Dissolve 1 lb. of oxalic acid in 2 gal. of water and add sufficient wheat flour to form a stiff paste. Cover the floor with the paste and allow it to remain for a few days; then scrub off thoroughly. This mixture contains both a solvent and an absorbent, and is usually effective in one application.

Philadelphia, Pa. R. H. KASPER.

WE HAD practically the same problem to contend with about two years ago. Oil had leaked from one of the turbine bearings, seeped under the baseplate and soaked the concrete thoroughly.

I tried to remove the oil with gasoline, pyrene, soda ash, and potassium hydroxide without success. At length the floor was washed with a weak solution (10 per cent) of sulphuric acid and later with a rag and soapy water. After drying the floor was given two coats of gray floor enamel. The oil seeped through the paint in one or two places but it was quickly wiped up and another coat of paint applied. No traces of oil were visible after that. The floor is walked on daily, but we have had no further trouble.

FRANK A. STEFFEY.
Plant Supernitendent
Texas-Louisiana Power Company
Alamogordo, New Mexico

■

Motors in Foundry Service

I should like to have the opinion of readers with foundry experience on the following questions: (1) Is it justifiable from the standpoint of lower maintenance and repair costs to install totally inclosed or ventilated motors, in place of the ordinary squirrel-cage type, for driving conveyors, tumbling barrels, and other power-driven equipment in grey iron and steel foundries? Has anyone any figures on the average cost of maintenance for these two types of motors in foundry or similar service?

(2) How often in general should open-type motors in foundry service be blown out? On what basis should the frequency of blowing out be determined? What is the maximum pressure of air that can be used in blowing out foundry motors without danger of injuring the windings through the abrasive action of the dust? T. O. D.

Buffalo, N. Y.

IF THE motor bearings are sealed, or ball-bearings are used, I find that the open motor gives good service in foundry work. When motors are totally inclosed considerable trouble is caused by heating unless the load is normal. Most foundry service is severe, how-

ever, and motors are subjected to a great deal of overloading.

One foundry in this district has two or three electric cranes that have been operating for 25 years. The motors are of the d.c. type, but they are open and the bearings are lubricated by grease cups. This form of lubricant tends to force impurities and grit out of the bearings. This company has had few rewind jobs and these were really due more to old age than to dirt. I doubt whether these motors have been blown out half a dozen times since they were installed.

I know of two other foundries that use 220-volt, three-phase squirrel-cage motors in the tumbling rooms. These motors are open and give very little trouble, mostly due to the bearings. If the new type of sealed sleeve bearings or ball bearings were installed I believe that practically all of their troubles would end.

Totally inclosed motors may be more reliable on certain drives, but they are bulkier and more difficult to assemble and inspect. One of the largest pipe fitting foundries in their district has a few totally inclosed motors and is of the opinion that the upkeep does not differ much from the upkeep of open-type motors.

I know that oil is motor insulation's worst enemy, but I have seen old-type motors of reliable manufacture from which grease and dirt had to be scraped from the coils, but the winding was as firm, although hardened, as the day it was installed. I have seen 220-volt, open-type a.c. motors with flour and oil so caked on the coils that it seemed that a compound had been applied to them. At the tipples of coal mines coal dust is usually caked on the motors until it is impossible to see through them. This is probably not beneficial, but it does not seem to affect their life appreciably. On the other hand, I know of totally inclosed motors that have failed after two or three years' service. So far they do not seem to have outrun the old, open-type motor. It is human nature for an inspector to put off checking the bearings of a totally inclosed motor just as long as it functions properly.

I am familiar with an installation of all open-type motors that are not giving any satisfaction. They are in an asphalt plant and drive conveyors, screens, and so on. The screenings and the loose, crushed material penetrate the bearings, collect in the windings and scrub out the coils. If these motors were cleaned up, new oil put in the reservoirs after they had been washed clean at the end of each week, and the dirt blown out at these periods the bearings would have much longer life.

For blowing out motors in foundry service I recommend about 20 lb. air pressure, or use of a vacuum cleaner. I would advise washing the motors every three to six months with carbon tetrachloride and baking. After baking either dip or spray the coils with a good, black insulating paint.

GRADY H. EMERSON.
Birmingham, Ala.

FROM the standpoint of lower maintenance and repair costs I find that totally inclosed, fan-cooled motors are the best for foundry use. We have 26 totally inclosed, fan-cooled motors in our foundry that have been in service almost four years and, except for lubrication, the only maintenance expense, incurred was the replacement of one bearing.

These motors have roller bearings and are greased every six months. When open-type motors were used in our foundry they were blown out every month, using 75 lb. per sq.in. air pressure. I had a ¼-in. pipe on the end of the air hose with a valve on it to regulate the pressure. CHARLES R. DEANER.
Chief Electrician
The Griswold Manufacturing Company
Erie, Pa.

USE OF totally inclosed, fan-ventilated motors in foundries is justified from every angle. The chief cause of motor failures in the steel and iron foundries with which I have been connected was the breakdown of insulation caused by oil leakage and infiltration of foundry dust.

I have found that a logical plan for reducing maintenance costs is to make a good electrician handle all the electrical work and assume full responsibility for a certain section of the plant. Do not let the operators do anything more than open and close the switches.

Blowing out and cleaning of motors should be governed by local conditions. A good blowing out about every two weeks is a fair average frequency. Do not use too high air pressure; if the finger can be held about 2 in. in front of the air hose nozzle without discomfort the pressure is safe to use on motors. C. A. WAGNER.
Denver, Colo.

■

City Gas for Metal Cutting?

I wish that readers would give me some information on the practicability of using ordinary city gas of 550 B.t.u. thermal value in metal cutting torches. (1) Will it be necessary to use oxygen with the gas, or will compressed air be suitable? (2) Under what pressures should the gas and air or oxygen be used? (3) What safety devices, if any, will be required? S.P.C.
Tonawanda, N. Y.

ORDINARY city gas will not be very satisfactory for most welding and cutting work. It is often used for lead burning, however, and it is necessary to use oxygen with it. It is also necessary to install a receiver between the gas supply and the torch to insure a uniform pressure. Pressures under which the gas and the oxygen should be used will vary with the nature of the work to be performed. Usually no special safety devices are required.

For all welding and cutting work where high temperatures are required, acetylene and oxygen should be used.

C. W. SCHWABE
Superintendent Mechanical Department
Mallinckrodt Chemical Works
St. Louis, Mo.

■

Paralleling Generator with Transformers

A 100-kw., three-phase, waterwheel generator normally runs in parallel with a bank of three 100-kw. transformers connected in closed delta to the power company's lines. These transformers are to be overhauled one at a time, while the remaining two transformers are operated in open delta at reduced load. Under these circumstances can the generator be synchronized with the open delta bank without trouble? Will this method of operation cause unbalance in any phase?
L.G.D.
Northampton, Mass.

IN ORDER to synchronize an alternator with a power company's system the following conditions must be fulfilled:

1. Alternator frequency must be the same as that of the system.
2. Phase rotation must be the same as that of the system.
3. Alternator voltages must be in phase with the system.
4. Alternator voltages must be the some value as those of the system.

Conditions 1 and 2 are fulfilled in this case, for they are the same with the open- or closed-delta connection.

Conditions 3 and 4 may be so closely approximated that for all practical purposes no trouble would be experienced.

Regulation of each phase of an open-delta transformer bank with balanced load is different from that of a closed delta bank, so that the three voltages of the system may be different in value and not 120 deg. apart when the transformers are carrying load. Whether results will be satisfactory or not depends upon the amount of unbalancing of the load, and upon its value.

Disconnect the transformer that is to be overhauled and synchronize the alternator to the open delta bank before any load is put on the system. Under this condition no trouble should be experienced. Throw some of the load slowly on the system, keeping the alternator floating on the line without load. Any unbalance resulting from the load on the open delta bank will be corrected

by the alternator taking the unbalanced currents, the magnitude of each varying with the field excitation of the alternator. Continue to increase the load in steps, loading the alternator in each case and adjusting the field excitation accordingly, watching the three currents of the alternator and the field excitation current. The load may be increased until the transformers are loaded to capacity (this case 174 kva. total three-phase load), or until the generator is carrying maximum allowable rated current in any one wire, or maximum allowable excitation current.

By decreasing field excitation, the three a.c. currents of the alternator may be decreased, but this may cause the alternator to take a leading current from the line, to which the power company may object. When the total load is on, the four conditions stated in the beginning should be obtained with the alternator neither over- nor under-excited.

E. MOLINET
The Cuban-American Sugar Company
Felicias, Oriente, Cuba

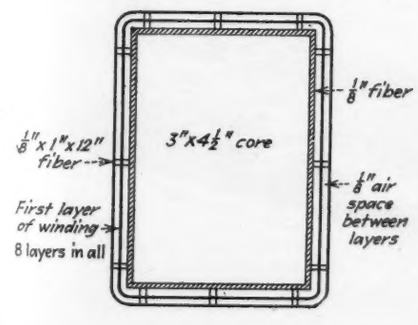
■

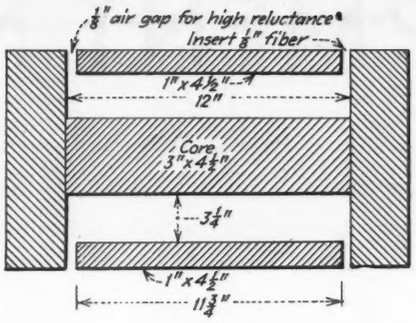
Using Rotary as Welding Generator

We have a Wagner type BC, model 14T, serial No. 134592, rotary converter rated 1,800 r.p.m., 60 cycles, three-phase, 55 amp. a.c., 70 volts, 50 amp. d.c. Tests have shown that it is good for 150 to 175 amp. continuously without exceeding 40 deg. C. temperature rise. By means of taps on the transformers and brush-shifting, voltages of 50 to 120 can be obtained with good commutation at full load. The voltage recovery is very rapid after a short circuit and the polarity does not reverse. (1) Can this machine be used for light arc welding? (2) What winding should be put on a shell-type laminated core, to be used as a series reactor, all three legs having a cross-section of 3x4½x12 in., with a winding space 1¾ in. deep on the center leg?

Burley, Idaho — V.H.K.

FROM my experience in the design and manufacture of arc welders of the rotary and dynamotor types, I would say that V.H.K.'s rotary can be used for ordinary welding. I advise him to use 50 volts for welding, with a variable resistance in series.





Data for the reactor or stabilizer are as follows: Wind on the 3x4½-in. core 80 turns of 66,400-circ.mil. bare wire (two No. 5 wires in parallel), using a suitable insulating cement between turns. The two magnetic circuits should be 1x4½ in., allowing a ⅛-in. air gap, as shown in the sketch, for high reluctance.

Cleveland, Ohio — EDWARD J. ALLEN.

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Changing from Salient to Consequent Poles

(Continued from page 256)

twelve consequent poles can be brought back to 220 volts. However, the chord factor for the twelve-pole connection is only 0.500, as compared to 0.9659 for six poles. The final twelve-pole series line voltage will then be 220 × 0.500 = 110 volts. Thus it is obvious that unless the original six-pole winding was four-parallel-connected, the twelve-pole, consequent, series connection would have to be operated on a 110-volt line, or the motor rewound for 220 volts, twelve poles.

Suppose this motor had a coil pitch of 1-and-5. The table shows that this coil pitch has a chord factor of 0.866 for both the six- and the twelve-pole connections; hence, the winding could be reconnected and a series connection would work satisfactorily for the consequent-pole, 220-volt winding.

With a six-pole winding and a pitch of 1-and-4, in the above case, the chord factor would be 0.707 for 50 per cent pitch. For twelve consequent poles this coil pitch is equivalent to 100 per cent, which means the twelve-pole chord factor is 1. With a series connection for twelve conseqent poles the line voltage would have to be 220 ÷ 0.707 = 311 volts, or if the motor were operated on a 220-volt line the starting and pull-out torques would be reduced and there would be a reduction in the maximum horsepower rating obtainable. This result follows from the fact that the torque of an induction motor varies as the square of the applied line voltage.

Another factor that also must be considered when changing from salient to consequent poles is the distribution factor. For all practical purposes it may be taken as 0.905 for two-layer, salient-pole, two-phase windings and 0.955 for three-phase, salient-pole windings. With the consequent-pole connection the two-phase distribution factor becomes 0.636, and 0.827 for three-phase, consequent-pole windings.

When considering the possibility of changing from salient poles to consequent poles, the proper procedure is, first, convert the salient-pole winding into line voltage terms equivalent to a series connection. Next, divide this voltage by 2, which will give the series, consequent-pole connection voltage. Check the coil pitch and correct this last voltage by the consequent-pole chord and distribution factors, as explained above.

A study of the table shows that a salient-pole winding that has a coil pitch between 70 and 75 per cent of full pitch for the smaller number of poles will make the most successful consequent-pole type of winding, because the chord factors for the salient and consequent poles are very nearly the same.

When the motor under consideration has a wound rotor with a lap winding, its connections also should be changed to form consequent poles. If the rotor is wave wound it cannot be connected for consequent poles. In this case if the stator can be reconnected for consequent poles the rotor will have to be rewound.

With squirrel-cage-type rotors the starting torque of the consequent-pole winding will in some cases be reduced and a higher starting current will be required to start the same load. However, by taking a cut off each endring, or putting a saw cut in the endrings between every rotor bar the starting torque can be brought back to normal.

If the starting equipment can be adjusted to give sufficient voltage to produce the necessary starting torque the endrings of the rotor should not be changed, because in this case the rotor will be of the low-resistance type, which will keep the running losses low.

EQUIPMENT NEWS

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these devices, which are designed to improve plant operation or reduce operating and maintenance costs

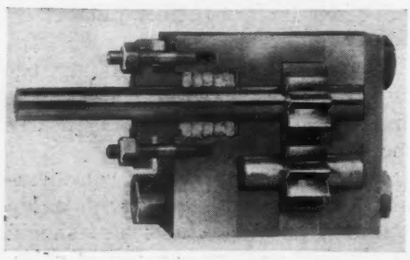
Northern Series XE Rotary Pumps

Northern Pump Company, Minneapolis, Minn., announces a line of "Nitralloy" steel rotary pumps to be known as the XE series, ranging in capacity from 14 to 42 gal. per min. at 1,200 revolutions per minute.

The laminated plate construction is the same as that used in smaller series XA and XD.

The pumps are designed especially for all types of oil services, including the handling of dirty crude oils and distillates at high pressures. For transporting non-lubricating oils, the pumps should be equipped with "Nitralloy" plate bearings as shown in the illustration. Roller bearing pumps are recommended for handling clean lubricating oil at pressures up to 1,600 lb. per sq.in.

These pumps with roller bearings are

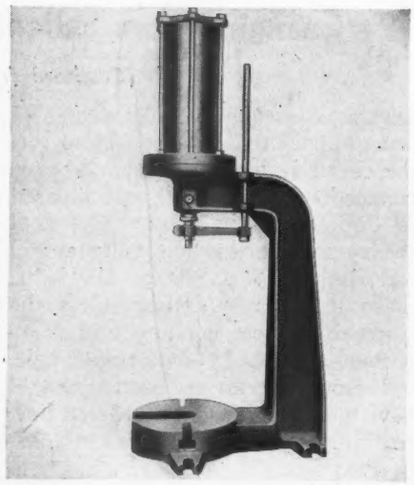


suited for installations on hydraulic hoists, lifts, cranes, conveyors, bulldozers, hydraulic snowplows, presses, dump trucks, stokers, machine tools, and road machinery.

■

Hannifin Air Operated Arbor Presses

Announcement is made by the Hannifin Manufacturing Company, 621 South Kolmar Ave., Chicago, Ill., of a line of air operated arbor presses designated as series A-1. The line is available in five sizes to deliver pressures ranging from 565 to 6,280 lb. per sq.in. The distance from the table to the ram of each unit is 11 in., and from the center of the ram to the back of the throat measures 8 in. Any length of stroke may be specified up to 10 in. Frames in all sizes are made of cast



steel. An important feature is that provision is made for guiding the ram to prevent turning. The presses may be obtained with either hand- or pedal-operated control valves.

Pittsburgh Equitable Meter and Merco Nordstrom Consolidate

Announcement is made of the consolidation of the Pittsburgh Equitable Meter Company, Pittsburgh, Pa., and Merco Nordstrom Valve Company, San Francisco, Calif. The latter company will operate as a division of Pittsburgh-Equitable Meter Company.

■

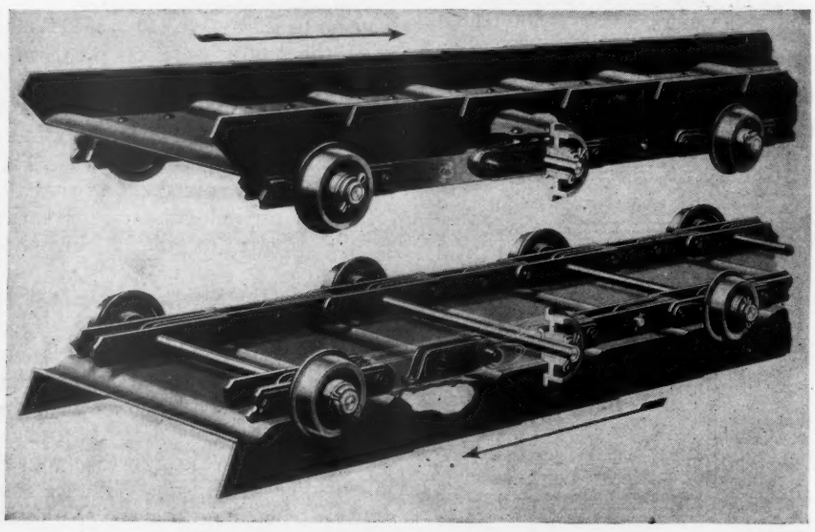
Broderick & Bascom "Flex-Set" Wire Rope

"Flex-Set," preformed construction wire rope, announced by the Broderick and Bascom Rope Company, 4203 North Union Blvd., St. Louis, Mo., is its regular "Yellow Strand," Plow Steel, "Patentsteel," and elevator rope with an added preforming feature. The other types, however, will still be continued.

■ ■

Webster-Weller "Gravity Seal" Apron Conveyor

For operation under exceptionally severe operating conditions the "Gravity Seal" steel apron conveyor has been developed by the Webster and Weller Manufacturing Companies, Chicago, Ill. Conveyor pans are attached to the chains by means of a pivot link. It is the operation of this link that causes the pans to overlap so that the possibility of leakage of material is reported to be eliminated without a loss in flexibility. Cross rods, mounted through the center of the chain links, are fitted with hardened bushings. Roller parts may be



replaced with little interference with the operation of the conveyor. Each pair of rollers carries the load of two full pan pitches on both the carrying and return run of the conveyor, and rollers are idle only while the apron passes over the sprockets. "Gravity Seal" construction is applicable to both apron conveyors and apron feeders and has been developed primarily to withstand the abrasive action of material handled in mines, cement mills, foundries, coke plants, and sintering plants.

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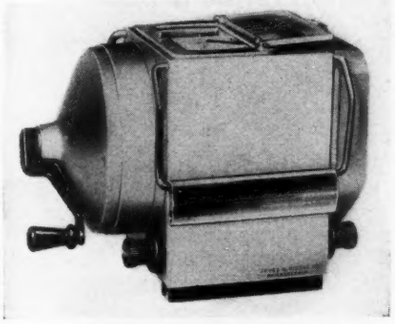
Biddle "Super-Meg" Insulation Tester

For routine tests of insulation resistance on most types and sizes of electrical equipment, a 2-range, 0 to 100 and 0 to 1,000 megohm "Super-Meg" tester has been introduced by the James



G. Biddle Company, 1211-13 Arch Street, Philadelphia, Pa. The instrument weighs 8¼ lb. and its overall dimensions are 5½x8⅝x6¼ inches.

■

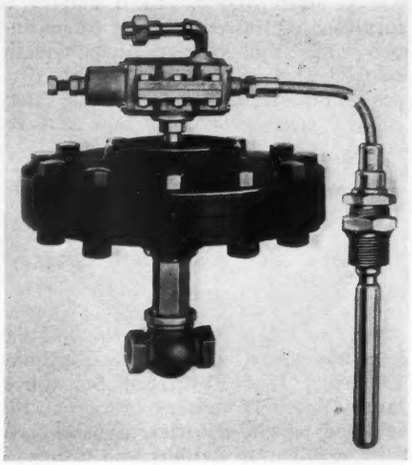
Highland Iron & Steel Announces Alloyed Puddled Wrought Iron

The Highland Iron & Steel Company, Chicago, Ill., an associate of the American Chain Company, Inc., announces that it is now in production on wrought iron alloyed with nickel, with copper, with nickel and molybdenum, and with copper and molybdenum, and that none of these alloys change the fibrous structure of the wrought iron. This development of alloyed wrought iron is expected to open greater fields of usefulness for this material because of its added strength in the as-rolled form.

■

Tagliabue Steam-Operated Controller

Steam pressure upon a diaphragm valve operates the temperature and pressure controller announced by the C. J. Tagliabue Manufacturing Company,

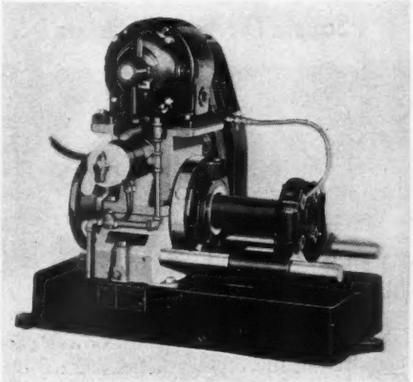


Park and Nostrand Aves., Brooklyn, N. Y. Variations in pressure do not affect the accuracy of control, because the action depends upon a differential of pressures above and below the diaphragm. Pressure above the diaphragm is regulated by means of an opening controlled by a thermostatic bellows, which is part of the usual thermostatic system including a bulb and tube.

■

Oster "Tom Thumb" Portable Pipe Machine

Regular pipe capacity of the No. 512 "Tom Thumb" pipe machine, announced by The Oster Manufacturing Company, 2067 East 61st Pl. Cleveland, Ohio, includes all sizes from ⅛ to 2 in., with an extra capacity down to and including ¼ in. It can be furnished either complete with an oil pump and base containing oil reservoir or, if the user prefers, he can oil the dies by hand. The machine also can be furnished with or without a pipe cutoff attachment. Dies are of the segment type. A separate diehead is used for each size pipe so that no time is lost in changing dies. Diehead is slipped around two vertical studs on the carriage. When cutting off, the diehead can be swung out of the way to provide clearance for the pipe. A V-belt is used for driving from the motor to a spiral micarta pinion, then to a spiral gear on the worm shaft. The

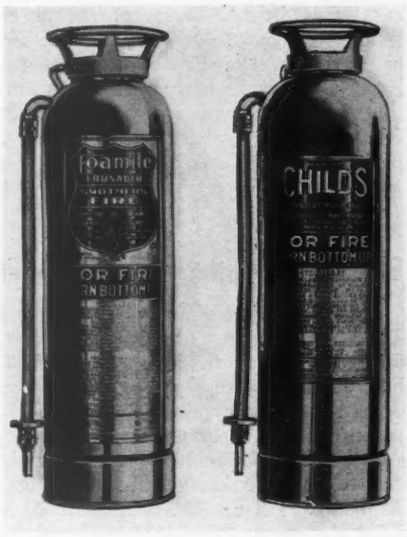


final drive to the spindle is a triple-thread worm mounted on roller bearings which are oiled automatically. A three-jaw, universal scroll-type chuck is mounted on the front end of the spindle, and a three-jaw universal centering chuck operated by a hand wheel is mounted on the rear of the spindle. The motor is universal, variable speed, and reversible.

■

American-LaFrance and Foamite Fire Extinguishers

Fire extinguishers designated "Foamite Crusader" and "Child's Model DS," have been announced by the American-LaFrance and Foamite Corporation, Elmira, N. Y. Both are of the 2½-gal. size. On each model the entire dome and shell are drawn from a single sheet of a corrosion-resisting alloy. The elbow is threaded and sweated into an extruded boss integral with the shell.



In the "Child's" extinguisher, the acid bottle is mounted in a spring wire cage to lessen the danger of bottle breakage through rough handling.

■

Worthington Model GA Water Meter

Worthington Pump and Machinery Corporation, Harrison, N. J., announces the Model GA water meter of the positive displacement disk type, developed for extremely low flows as well as for intermediate and high flows. It is built in sizes from ⅝ to 2 in., with normal flow limits from 1 to 160 gal. All register gears are fitted with rubber bushed bearings. The register box is fitted with a double lid to facilitate cleaning of the cover glass. The train assembly is comprised of four bronze gears and four pinions, fastened to

monel metal spindles which revolve in renewable hard rubber bushings. The disk or measuring chamber is in two sections, held together by a snap joint without screws. This construction permits the case to separate without distortion in the event of freezing. Additional protection is secured by the use of a cast iron frost bottom on the three smaller meters. Although it is sufficiently strong to withstand the pressures encountered in regular service, this bottom breaks when the water in the meter freezes, relieving the strain on interior parts.

■

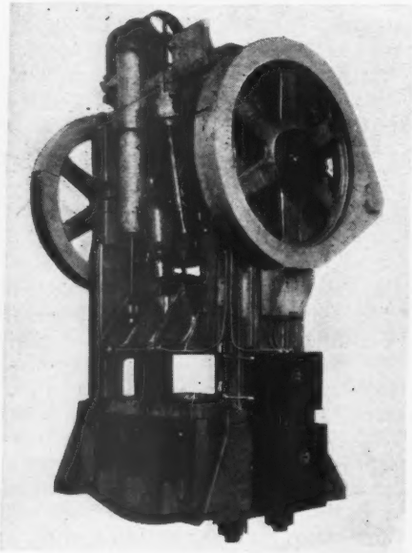
Electric Controller Lifting Magnet

A lifting magnet, known as the No. 3½ Type SA magnet, 39 in. in diameter, for use with overhead, crawler, gasoline, or automotive type cranes in foundries, scrap yards, railway stores, maintenance of way departments, warehouses, and the like, is offered by The Electric Controller and Manufacturing Company, 2696 East 79th St., Cleveland, Ohio. A 5-kw. d.c. generator is required. Renewable pull shoes and the manganese steel outer bottom plates are held in position against the machined surfaces of the magnet housing by self-locking through bolts. The moisture-resisting magnet coil is strap wound. Each magnet is furnished with two collecting cables and two cable connectors. An automatic controller, consisting of a small two-position master switch and a steel safety cabinet containing contactors and resistors, is furnished.

■

Clark "36" Automatic Press Control

An automatic press control unit has been announced by the Clark Controller Company, 1146 East 152d St., Cleveland, Ohio. It consists of two totally inclosed panels, a series of palm-operated push button stations, and two small limit switches which operate in conjunction with a magnetic brake and magnetic pulley. Sequence is so designed that the magnetic spring is always released

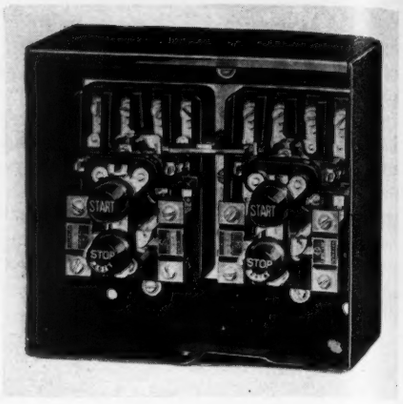


before the clutch is engaged for the start of a cycle, and always disengaged before the magnetic brake is set at the end of a cycle. Several types of operations may be obtained by the proper setting of the drum selector switch, and the case housing the selector switch can be padlocked to prevent tampering.

■

Square D Manual Starters

Two a.c. manual starters for controlling across-the-line motors—a two-speed, separate-winding type and a single-speed reversing type—have been announced by the Industrial Controller Division, Square D Company, Milwaukee, Wis. Although both types have general application, the two-speed type is especially suitable for heating and ventilating purposes and similar installations where remote control is not essential. The maximum horsepower ratings of the three-pole starters are 5 hp.

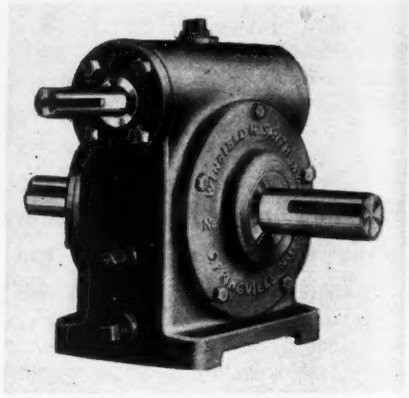


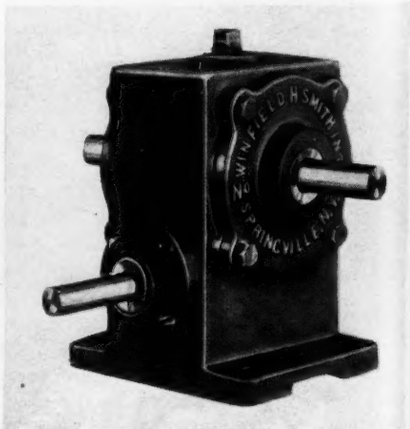
at 220 volts and 7½ hp. at 440-550 volts. Features of the starters are front operation; thermal overload protection; operation of any relay opens main line completely disconnecting motor from line; two quick break switch mechanisms interlocked to prevent simultaneous operation; and pushbutton reset without replacement of any parts after an overload. Maximum dimensions are 13⅜ in. wide, 10⅞ in. high, and 5½ in. deep.

■

Smith Speed Reducers

Two additional series of worm gear speed reducers are offered by Winfield H. Smith, Inc., Springville, N. Y. The No. 3½B is designed for transmitting





loads up to ¼ hp. Its worm gear is of phosphor bronze and mounted on roller bearings. The worm is of hardened steel cut integral with the worm shaft. Oil seals protect all shaft extensions. Standard ratios for this unit are 58-1, 36-1, 18-1, and 9-1. The No. 4½T Model is designed for medium duty, with the worm located above the gear. Its worm is cut integral with the high-speed shaft. The worm gear is of phosphor bronze and is keyed to the slow speed shaft, which is mounted on roller bearings. Oil seals and drill return passages tend to prevent oil leakage. Standard ratios and horsepower capacities (based on 1,750 r.p.m. of the high-speed shaft) range, respectively, from 1-6 to 1-60, and from 1.50 to 0.25.

■

Lyon Steel Tool Cabinet

Lyon Metal Products, Inc., Aurora, Ill., announces a steel tool cabinet designed for the storage of tools used on individual jobs. The cabinet may be placed within arm's reach of a job and

may be locked at night. It weighs 102 lb.; is fitted with three shelves in addition to the top and bottom trays; and is 21¼ in. wide, 15½ in. deep, and 34 in. high. The unit is finished in olive green baked enamel.

■

Kron Scales

The Kron Company of Bridgeport, Conn., formerly American Kron Scale Company, announces that it has improved its line of industrial scales as regards appearance and operating mechanism. Dials have been made richer in appearance and more sensitive in action. Over 48 bearing points have been eliminated in the dial mechanism; the 6 remaining bearing points are of the anti-friction type. The pivot points are ball bearings, of high carbon chrome steel with accuracies in tolerance to within less than one ten-thousandth of an inch. Coefficients of friction of bear-

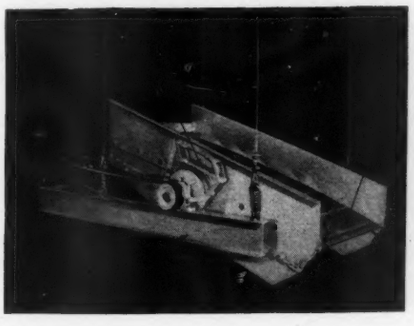
ings are reported to remain constant under a broad range of temperatures and loads. Bearings are sealed in a dust-proof housing. The sector has been constructed to offset any vibration that may be present in the building in which the scale is located. The pointer is designed to remain steady at the proper weight. There is one point of adjustment for the scale. The face of the scale is bordered by a chromium plated ring on both outer and inner circles.

■

Stephens-Adamson Vibrator Screens

Each unit of a line of vibrator screens, announced by the Stephens-Adamson Manufacturing Company, Aurora, Ill., is custom built to suit the material handled. The screen is of the positive vibration type, in which a rigid screen body with one or more decks is given a vibration of fixed amplitude by the rapid throw of an eccentric shaft. There are three units—screen body, vibrating mechanism, and sub-frame. The vibrating mechanism consists of an eccentric shaft, adjustable balance wheels, double-row ball bearings, grease seals, and a tubular housing. Before recommending screens, definite data on materials, sieve analysis, capacities, and characteristics are required. From this information, the vibrating unit and drive are assembled to give the desired vibration frequency.

Other features are quick-change screen panels and a stabilizer mounting. The quick-change panel is a piece of screen cloth with a cross angle

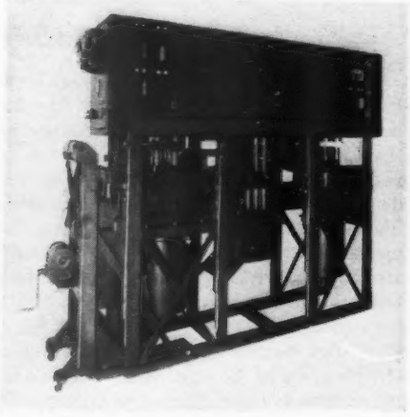


brazed to each end. The panel is installed by sliding it up the tubular deck supports until the ends of the upper cross angle drop into sockets in side frames. After stretching levers are slipped on the ends of the lower angle, they are tightened. Time tests indicate that two men can change or reverse a panel on either an upper or lower deck in about 15 min. The stabilizer unit, made up of parallel arms, holds the screen body at the desired screening angle without the use of corner balancing springs or bumpers. The unit connects screen body and sub-frame in such a way that the screen is free to vibrate and yet is held at a given angle.

■

Delta-Star Metal-Clad Switching Arrangement

Delta-Star Electric Company, 2400 Block, Fulton St., Chicago, Ill., has developed a metal-clad switching unit that

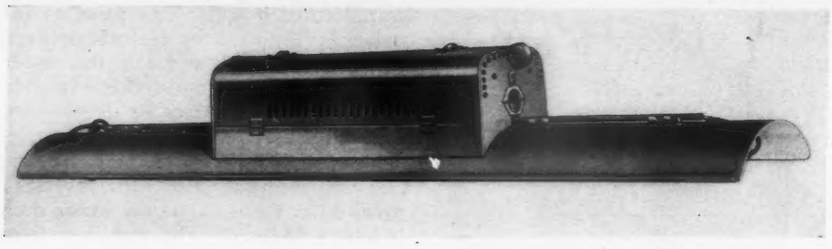


is provided with a main and transfer bus to control 4,100-volt, three-phase feeder circuits equipped with three single-phase regulators. Interlocks make it impossible to energize the feeders more than one way. Means are provided for putting the regulators in or out of service. By means of a portable truck the main and regulator breakers can be removed or placed in service quickly. The entire unit inclosing the oil circuit breaker is of fabricated steel welded construction.

■

American "Preformed" Wire Rope

"Preformed" wire rope, patented by the American Cable Company, 230 Park Ave., New York, N. Y. is now also manufactured in the United States under that company's license by the MacWhyte Company, 2936 14th Ave., Kenosha, Wis. Internal stress is said to be eliminated from preformed wire rope by preforming the strand and wire to the exact helical shape the threads and wires assume in the finished rope structure.



General Electric Cooper Hewitt Lamp

The General Electric Vapor Lamp Company, Hoboken, N. J., announces a Cooper Hewitt mercury-vapor lamp for industrial lighting. Changes in the tube construction include: straight tube; positive terminals, reduced in length, in the plane of the tube; negative terminals, also reduced in length, relocated at the top of the bulb; all terminals of intermediate screw base, screw shell type, and, by means of insulating covers, attachable by hand. Reflector design now embodies rounded corners, concealed wiring, more reflecting surface than on the old model, and permits complete covering of the tube at both ends. These changes limit the operating position to horizontal, for one style, and vertical for another, although units are available for angular operation.

■ ■

Lincoln Safety Pushbuttons

The Lincoln Electric Company, Cleveland, Ohio, announces that it has redesigned its line of safety pushbuttons so that the start button of each unit is inside of the stop button. The redesigned safety pushbutton is known as Type A-31. The stop button can be operated from any angle by merely striking the front of the control box with the flat of the hand, but the start button must be operated with the finger. The stop button can be locked in the "off" position by pushing it in and twisting it to the right. The button will handle control circuits up to 600 volts a.c. or d.c. because of its large contact opening. Contacts are of the double-break, solid-copper type that operate with a positive wiping action. They are inclosed in a dust-proof, molded asbestos case. The button is self contained and need not be taken apart or even removed from the box cover for wiring. All terminals are marked and brought out of the back of the case.

■

Hercules Liquid Resin

Development of liquid resin to be known as "Abalyn" has been announced by the Naval Stores Department of the Hercules Powder Company, Wilmington, Del. The product is a resinous plasticizer for nitrocellulose lacquers and other products. Its properties indicate that it will find application in the manufacture of such products as clear interior lacquers for metal and wood, alkali-proof lacquers, leather lacquers, coatings for fabric and paper, non-drying inks, rubber cements, adhesives, waterproofing compositions, transparent paper, and similar products. The product is a pale yellow viscous resin that has a solvent action on nitrocellulose in the presence of alcohols. Other properties claimed for the resin are that it is not affected appreciably by alkalies or weak acids; it does not hydrolyze with boiling water; it has a faint, ester-like odor; and it is insoluble in water.

■

Tidy Products Tilt Trucks

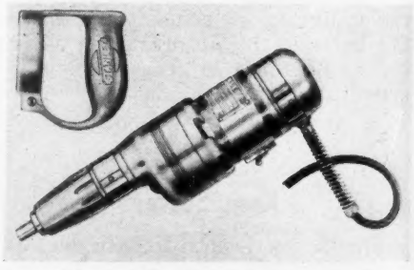
"Truly-Safe" is the trade name of a line of barrel, carboy, and drum tilt trucks announced by Tidy Products, Inc., Chrysler Bldg., New York, N. Y. Each truck is of electrically welded construction and is designed so that its center of gravity is in line with the wheels. Model CT, for round or square carboys up to 250 lb. in weight, is constructed so that its wheels retract while loading. It is provided with a handle lock that holds the carboy securely in position while pouring. It weighs 35 lb. Model DT weighs 55 lb. and is designed for loads weighing up to 850 lb. Its handle forms a safety latch. Model

UDT is a combined barrel lift truck and drain stand. This truck weighs 65 lb. and is designed to handle an 850-lb. load.

■

Stanley Portable Electric Screwdriver

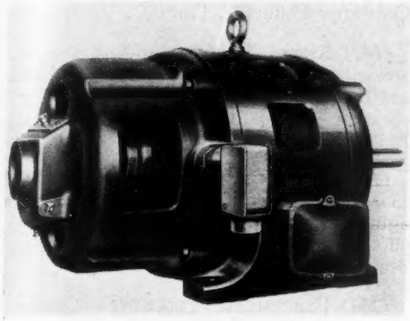
The Stanley Electric Tool Company, New Britain, Conn., announces a portable electric screwdriver. A feature of the tool is a clutch mechanism designed



so that it releases at the exact pressure for which it has been set. This action is reported to stop the screws from going too deep in the wood, to prevent damage to the work and screw slots, and to eliminate the hazard of overloading the motor or stripping the screw threads. The unit weighs 4¼ lb. It is designed to drive up to No. 8 screws in hard wood and up to No. 10 screws in soft wood. With socket wrenches it will run on nuts up to ¼ in. in machine screw size.

Century Slipring Motors

Century Electric Company, St. Louis, Mo., has extended its line of slipring motors from 20 hp. to 250 hp., 1,800



r.p.m., 60 cycles. The complete line now ranges in size from ½ to 250 horsepower.

■

National Carbon Non-Resilient Brushes

National Carbon Company, Inc., Cleveland, Ohio, announces an electrographitic brush known as the National Pyramid Grade No. 234. The outstanding characteristic claimed for the brush is a non-resilient structure—a property reported to enable the brush to maintain exceptionally firm contact on commutators of high peripheral speed. Improved commutation, low friction, high carrying capacity and smooth riding properties, are benefits said to follow use of the brushes. The field of application of the products is for heavy duty d.c. generating and substation equipment.

■

Goodrich Rubber Tank Lining

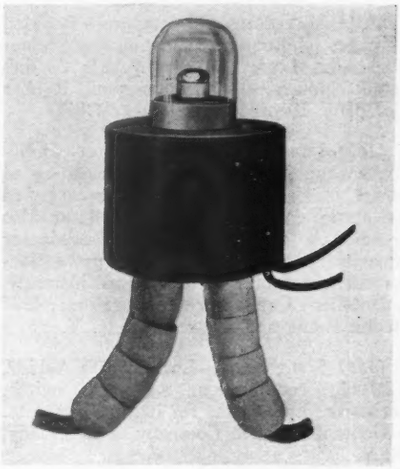
"Triflex" rubber tank lining, adhered to the tank walls by the "Vulcalock" process and protective sheathings of wood or brick, has been announced by the B. F. Goodrich Company, Akron, Ohio. The development is reported to afford structural strength and permanence hitherto unattainable in pickling work.

The lining is constructed of a layer of hard rubber cushioned between two layers of soft rubber. The hard rubber serves to resist the penetrating and deteriorating effects of acid, oils, and oxidation and also to impart mechanical strength and stiffness to the lining. The soft rubber layers serve to cushion the hard layer from the effects of sharp blows. Special expansion joints are provided which absorb strains incident to expansion and contraction with temperature changes, thus preventing distortion and crackling of the hard rubber. Relative thickness of the three plies may be varied within wide limits to obtain desired properties for each type of service. Sudden variations in temperature are claimed to have no adverse effect on the three-ply construction with expansion joints. Brick or wood sheathings are installed to insure freedom from damage to the rubber through gouging or impact of heavy steel parts. Brick sheathings also have the merit of lowering the temperature at the rubber surface.

■

Providence Electric Mercury Switches

Providence Electric Controls, Inc., 763 Allens Ave., Providence, R. I., announces a line of mercury switches, ranging in capacity from 1 to 100 amp. In types up to 5 amp. special heat resisting contacts are used. In the larger switches arcing takes place over a ceramic surface. A feature is the "Magnetrole" mercury switch which operates entirely by magnetic control. A gas filled tube containing two mercury pools and a floating displacement member is placed within the field of an electrical coil. When the coil is energized the floating piece within the tube is drawn down, displacing a certain amount of mercury. This movement causes a rise in the level of one of the mercury pools with a consequent merging of contacts. The arc takes place around the edge of a treated ceramic tube.



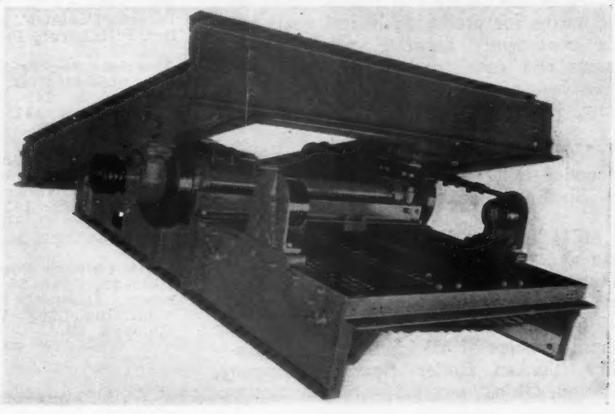
■ ■

Link-Belt Heavy-Duty Vibrating Screens

Two types of heavy-duty vibrating screens have been announced by Link-Belt Company, Philadelphia, Pa. They are the positive drive and the unbalanced pulley types. Both types are available with single or multiple decks. They are designed for applications in which large screen openings are required and heavy capacities must be handled.

The positive drive type can be furnished to provide any given fixed amplitude, with shaft speeds to suit. Any given amplitude will cover a wide range of screening surface openings. The angle of the screen inclination, the speed of operation, and the direction of its rotation can be changed at any time to suit the kind, size, and condition of the material to be screened. The direction of rotation determines whether the vibrations are in a direction that is with or against the flow of the material. Screen cloths are placed under crosswise tension by side tension members, which also serve as wearing plates and prevent material from leaking along the edges. Cantilever leaf springs serve to maintain the screen box at a constant angle. They are adapted for the circular motion produced by the action of the eccentric-driven positive drive. Oversize self-aligning roller bearings are used. A steel sub-frame is furnished regularly as a part of the screen. It can be supported from below or hung by cables from above.

The unbalanced pulley type of screen is designed for high-speed work where the material is of a sticky nature, and on close-sizing problems where the screen openings are not large. The total movement or amplitude of this screen can be varied by the user from zero to about ¼ in. by changing the counterweights in the weight containers. The angle of the screen and the speed and direction of operation also can be changed by the user to suit operating conditions. The entire weight of the screen box rests on cantilever leaf springs and responds to the reactions therefrom. The bearings, the method of applying screen cloth, and the cantilever leaf spring design are the same as those previously described for the positive drive type of screen.



TRADE LITERATURE

For copies, address the manufacturers concerned

■

(161) MATERIALS HANDLING — Booklet, 24 pages, photographs showing various applications of the belt conveyor in 27 different industries.—The Diamond Rubber Company, Incorporated, Akron, Ohio.

(162) POWER FACTOR CORRECTION—Bulletin, a simple discussion of the meaning of power factor and how it can be corrected by static condensers. The bulletin also contains a scale whereby the condenser capacity required for any given power factor correction may be determined instantly. —Dubilier Condenser Corporation, 4377 Bronx Boulevard, New York, N. Y.

(163) SWITCH — Leaflet GEA-1587, CR7008, combination magnetic switch, across-the-line starter for induction motors. —General Electric Company, Schenectady, N. Y.

(164) CONTROL—Bulletin A-13, combined pressure and low water control for boilers. —The Mercoid Corporation, 4201 Belmont Ave., Chicago, Ill.

(165) WIRE ROPE—Booklet, 20 pages, "The Cardinal Reasons Why You Save Money With Tru-Lay."—American Cable Company, 230 Park Ave., New York, N. Y.

(166) MULTI-V-DRIVES — Bulletin L-400-B2A, 12 pages, rubberized cord belts operating in V-grooved sheaves.—Worthington Pump and Machinery Corporation, Harrison, N. J.

(167) LIGHTNING PROTECTION — Booklet No. 2 of a series, "Construction and Operation of Crystal Valve Lightning Arresters."—Electric Service Supplies Company, 17th and Cambria Sts., Philadelphia, Pa.

(168) OIL SEALS — Booklet, 16 pages, "They Shall Not Pass." Diagrams showing the application of a seal to various types of machinery. Tabulations of sizes and dimensions. — Aetna Ball Bearing Manufacturing Company, 4600 Schubert Ave., Chicago, Ill.

(169) HELICAL GEARS—Booklet, 36 pages, the results of investigation to determine the causes of inaccuracies in helical gears and the means for producing helical gears that are consistently accurate, together with charts and data from which conclusions have been drawn.—Barber-Colman Company, Rockford, Ill.

(170) BELTS—Folder, "Tannate Special Rounded Belt."—J. E. Rhoads & Sons, 35 N. Sixth St., Philadelphia, Pa.

(171) TESTING EQUIPMENT—Booklet, 12 pages, "Timken Wear and Lubricant Tester" for making tests on the load carrying capacity of lubricants, the measurement of friction, and for determining the wear characteristics of all kinds of materials.—The Timken Roller Bearing Company, Canton, Ohio.

(172) WATER FLOW—Armco Engineering Bulletin No. 5, "The Flow of Water in Armco Spiral Welded Pipes."—The American Rolling Mill Company, Middletown, Ohio.

(173) ELECTRIC HEATING—Bulletin 270, 8 pages, "Falcon" bare electric immersion heating units for large tanks.—H. O. Swoboda, Inc., 3530 Forbes St., Pittsburgh, Pa.

(174) LUBRICATION — Technical Bulletin 130.3, "Colloidal Graphite as a High Temperature Lubricant."—Acheson Oildag Company, Port Huron, Mich.

(175) PIPE TOOLS—Folder 232, the approved line of Beaver pipe tools.—The Borden Company, Warren, Ohio.

(176) BALL BEARINGS — Auburn ball bearing data book, 36 pages, illustrations and technical data.—Auburn Ball Bearing Company, Rochester, N. Y.

(177) AIR COMPRESSORS — Bulletin L-620-S2, 4 pages, vertical single-cylinder, two-stage units, 10.7 to 61 cu.ft. per min. displacement. — Worthington Pump and Machinery Corporation, Harrison, N. J.

(178) MOTORS — Folder GEA-1542, 4 pages, Type B constant speed, ball- or sleeve-bearing d.c. motors.—General Electric Company, Schenectady, N. Y.

(179) WELDING SUPPLIES—Catalog, section 3304, 24 pages, arc welding supplies.—The Lincoln Electric Company, Cleveland, Ohio.

(180) RUBBER — "A Wonder Book of Rubber," 48 pages, the story of rubber and the manufacture and use of rubber products.—The B. F. Goodrich Company, Akron, Ohio.

(181) ELECTRICAL PRODUCTS—Pages 26A, 28C and 67B, Catalog 15. Revised lists and new material added to catalog pages. —The Trumbull Electric Manufacturing Company, Plainville, Conn.

(182) STEEL PLATE — Folder, sheared, pressed and cut-to-shape steel plate blanks and detail plates.—By-Products Steel Corporation, Broad Street Station Building, Philadelphia, Pa.

(183) LIGHTNING ARRESTERS — Bulletin 336, 80 pages, Keystone crystal valve lightning arresters.—Electric Service Supplies Company, 17th and Cambria Sts., Philadelphia, Pa.

(184) ELECTRICAL PRODUCTS — Catalog, 10 pages, "Ilsco" electrical products.—Ilsco Copper Tube & Products, Inc., 5629 Madison Rd., Cincinnati, Ohio.

(185) MACHINING—Booklet F 1214, "Precision Hobbing," a summary of the problems encountered in gear cutting where accurate work with good finish is required. —Barber-Colman Company, Rockford, Ill.

(186) BURNING GASEOUS AND LIQUID FUELS—Reprints of three articles, "Tangential Firing of Gaseous and Liquid Fuels," "Corner-Firing of Blast Furnace Gas" and "Combination Burning of Blast Furnace Gas and Pulverized Fuel."—Combustion Engineering Corporation, 200 Madison Ave., New York, N. Y.

(187) CIRCUIT BREAKERS — Bulletin C. 1937, "Type AB De-ion Circuit Breakers" for low voltage, 50-225 amp.—Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

(188) POWER TRANSMISSION—Reprint of a series of articles, "Power Transmission by Roller Chains — Their Construction, Operation, Selection, Application, Lubrication, and Maintenance."—Diamond Chain and Manufacturing Company, Indianapolis, Ind.

(189) COATED METAL—Reprint, "Porcelain Enameled Metal" by Bernard J. McGarry.—Ferro Enamel Corporation, Cleveland, Ohio.

(190) POWER—Bulletin, 12 pages, "How Six Representative Concerns Cut Power Costs."—Troy Engine and Machine Company, Troy, Pa.

(191) PRESSED METAL — Booklet, 16 pages, "In Harmony With Modern Progress," illustrations of some pressed metal parts being produced by this company. Geuder, Paeschke and Frey Company, St. Paul Ave. at 15th St., Milwaukee, Wis.

(192) BOILERS—Bulletin B-32-3, 48 pages, various types of boilers.—Foster Wheeler Corporation, 165 Broadway, New York, N. Y.

(193) CONTROLLER — Bulletin 1024, 4 pages, steam operated temperature and pressure controller.—The C. J. Tagliabue Manufacturing Company, Park and Nostrand Aves., Brooklyn, N. Y.

(194) CIRCUIT BREAKERS—Catalog 5, 16 pages, open and inclosed air circuit breakers. — Roller-Smith Company, 233 Broadway, New York, N. Y.

COMING EVENTS

Association of Iron and Steel Electrical Engineers — Exposition and Convention, William Penn Hotel, Pittsburgh, Pa., June 20 to 23, 1932. Managing Director, John F. Kelly, Empire Building, Pittsburgh, Pa.

American Society for Testing Materials —Annual Meeting, Atlantic City, N. J., June 20 to 24. Assistant Secretary, R. E. Hess, 1315 Spruce St., Philadelphia, Pa.

Illuminating Engineering Society—26th Annual Convention, New Ocean House, Swampscott, Mass., during the week of Sept. 26th, 1932. Assistant Secretary, Frank G. Horton, 29 West 39th St., New York, N. Y.

Sixth Chicago Power Show—Coliseum, Chicago, June 25 to 30, 1933. Managers, Midwest Engineering Exposition, Inc., 308 W. Washington St., Chicago, Ill.

MAINTENANCE ENGINEERING'S DATA SHEETS

Suggested Material for Plant Fire Brigades

THE FOLLOWING is intended to show what can be installed in order to provide for most emergencies in a large plant. Small plants should be guided accordingly. This is entirely emergency apparatus and additonal to the standard requirements for floors and yards. Any organization being formed should obtain expert advice before equipping its fire station.

Fire Station Equipment

1. Isolated, fire-resistive building in center of works
2. Framed plan of water mains with all section control, sprinkler valves, hydrants and fire alarm boxes shown and numbered
3. Framed plan of watchman's route and stations
4. List of fire brigade membership with addresses and telephone numbers of chief and other officers, works manager, public fire department, and doctor
5. Drill attendance book
6. Hose and chemical extinguisher record book
7. Inspections forms, and files for copies
8. Red tag valve control board and supply of red tags
9. Desk with drawers and chair
10. Set of National Board of Fire Underwriters' pamphlets applicable to local plant; Field Practice Manual (N.F.P.A.), and standard handbooks on fire protection
11. Notice Board
12. Couch
13. One first aid kit. Artificial respiration chart

Apparatus

1. 6 fire buckets
2. 6 carbon tetrachloride extinguishers
3. 3 2½-gal. soda acid extinguishers
4. 3 2½-gal. foam type extinguishers
5. * firemen's helmets. * pairs woolen mitts
6. * pairs firemen's rubber boots (half hip), without nails in heels
7. * pairs firemen's rubber coats, belts and spanners
8. 12 kerosene lanterns trimmed, supply of safety matches
9. 1 hose reel, 400 ft. spare hose
10. Reel equipment: axe, steel bar, 1 nozzle, 4 wrenches, 7 hose straps, spare washers and hydrant cut-out valve
11. 75 ft. of ½-in. rope
12. 1 20-gal. or 40-gal. chemical engine
13. 2 dozen hose straps
14. 6 axes
15. 1 crosscut saw (2 handled)
16. 1 rip saw
17. 4 spare 1⅛-in. play pipes, 2 flexible play pipes, with shut-off nozzle
18. 100 ft. of ½-in. Manila rope
19. 200 ft. of ½-in. Manila rope and hook
20. 3 electric lanterns
21. 2 strong steel crowbars
22. 1 ladder, at least 24 ft., or of sufficient length for the work required
23. 6 salvage tarpaulins
24. 1 deluge set, 3-way Siamese nozzles 1½ to 2 in.
25. 4 double female hose couplings
26. 6 hydrant cut-out valves
27. 4 dozen hose coupling washers
28. 1 door opener
29. 2 smoke helmets

*One for each member of department

Courtesy National Fire Protection Association

(Continued on the following page)

Suggested Material for Plant Fire Brigades

(Continued from the preceding page)

SPARE EQUIPMENT AND STORES

1. 12 spare lantern globes
2. 3 shovels
3. 2 pitchforks
4. 1 wheelbarrow
5. 2 oil cans
6. 1 1-gal safety can for alcohol for thawing out frozen valves and hydrants; 1 can for kerosene
7. 1 hand pump for excavations
8. 2 kerosene oil heaters for emergencies
9. 1 work bench, vise, sundry small tools, spanners, hammers, and so on
10. 24 fusible links for fire doors
11. 100 165-deg. sprinkler heads
12. 50 212-deg. sprinkler heads (only required if 212-deg. heads are used)
13. 25 286-deg. sprinkler heads (only required if 286-deg. heads are used)
14. 25 360-deg. sprinkler heads (only required if 360-deg. heads are used)
15. 25 ordinary heads, "corroproofed" (only required if "corroproofed" heads are used)
16. 6-, 8-, 10-, and 12-in. soft wood taper plugs and wedges for water mains. Keep well oiled
17. Hemp for pipe joints
18. 100 lb. lead for pipe joints
19. 1 hose-coupling expander
20. 24 expander rings, $2\frac{1}{2}$ in., or local standard
21. 150 ft. spare $1\frac{1}{2}$-in. unlined linen hose (if used)
22. 12 clips for unlined linen hose (if used)
23. 4 spare $1\frac{1}{2}$x$\frac{3}{8}$-in. brass band hose nozzles
24. 400 lb. coarse salt
25. 1,000 lb. calcium chloride for anti-freezing solutions
26. 300 lb. bicarbonate of soda
27. 4 gal. sulphuric acid
28. 5 gal. special carbon tetrachloride fluid for 1-qt. extinguishers
29. 1 dozen spare acid bottles and stopples for extinguishers
30. 1 dozen spare hose and nozzles for extinguishers, also cap washers
31. 1 spare hydrant valve and spindle complete
32. Spare rubber seats for dry-pipe valves (if required)
33. 40-ft. extension ladder for sprinkler replacements
34. 1 barrel of sawdust (preferably hardwood sawdust) and sieve
35. 1 strainer and funnel for filling chemical extinguishers
36. 1 small funnel for filling carbon tetrachloride extinguishers
37. 1 pair of scales, 25-lb. capacity
38. 1 pint measure
39. 1 quart measure
40. 36 charges for foam type extinguishers
41. 1 set sprinkler fittings complete for 6 in. section
42. 3 spare lengths, 6-, 8-, 10-, and 12-in. C. I. pipe for water mains
43. Spare lengths $\frac{3}{4}$-, 1-, $1\frac{1}{4}$-, $1\frac{1}{2}$-in. W. I. pipe
44. Spare parts for small dry valve fittings
45. Pressure gage
46. 1 tap and die for standard hose coupling threads